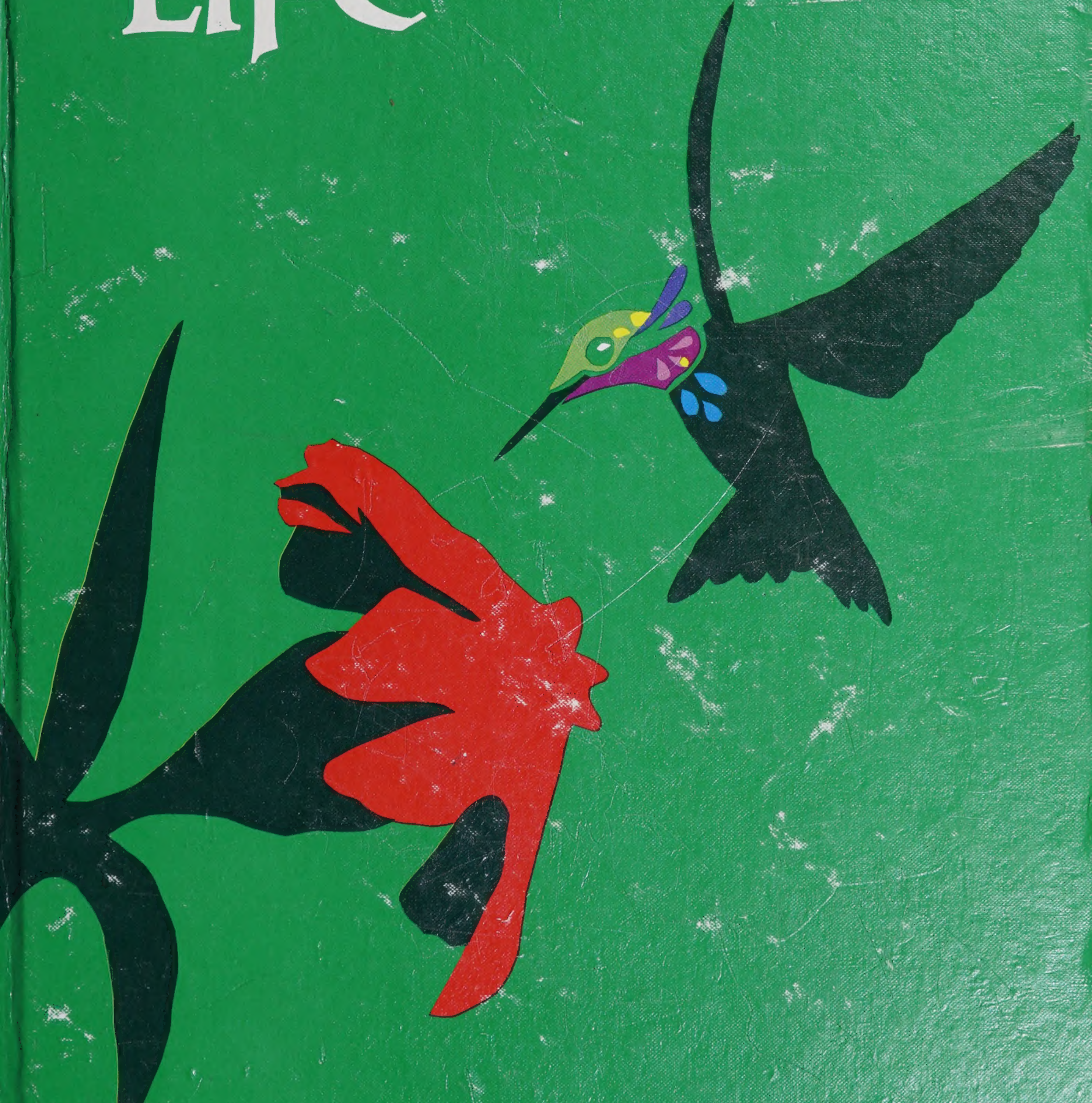
LIFE *activities and explorations*



Teacher's Edition

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Teacher's Edition

LIFE

Activities and Explorations

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Houghton Mifflin Company · Boston
Atlanta Dallas Geneva, Illinois
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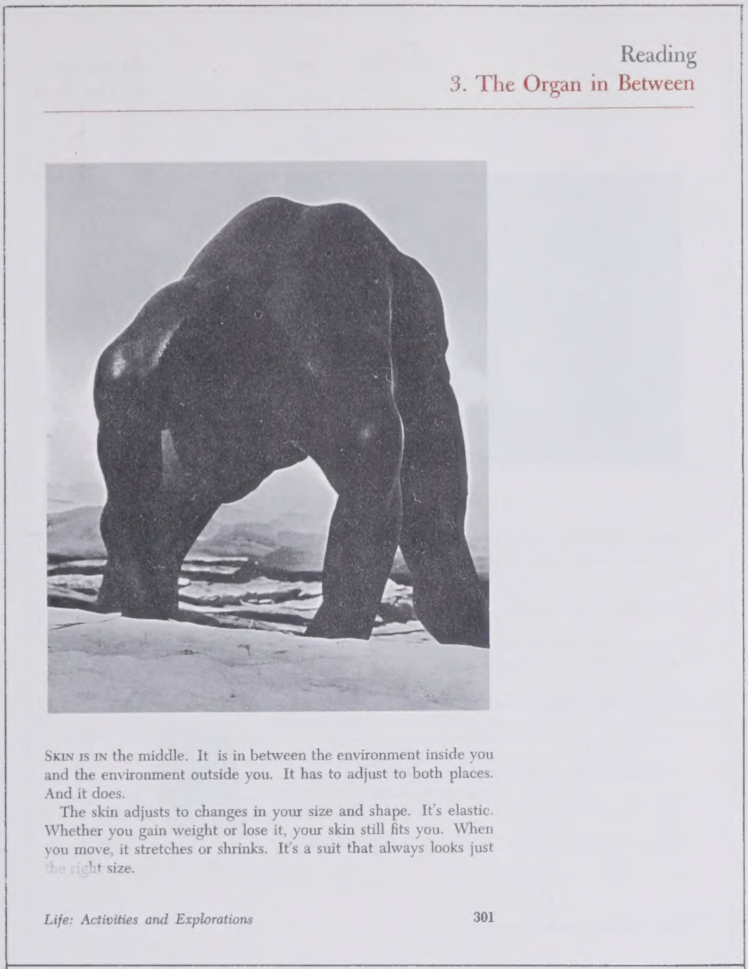

Reading
3. The Organ in Between

SKIN IS IN the middle. It is in between the environment inside you and the environment outside you. It has to adjust to both places. And it does.

The skin adjusts to changes in your size and shape. It's elastic. Whether you gain weight or lose it, your skin still fits you. When you move, it stretches or shrinks. It's a suit that always looks just the right size.

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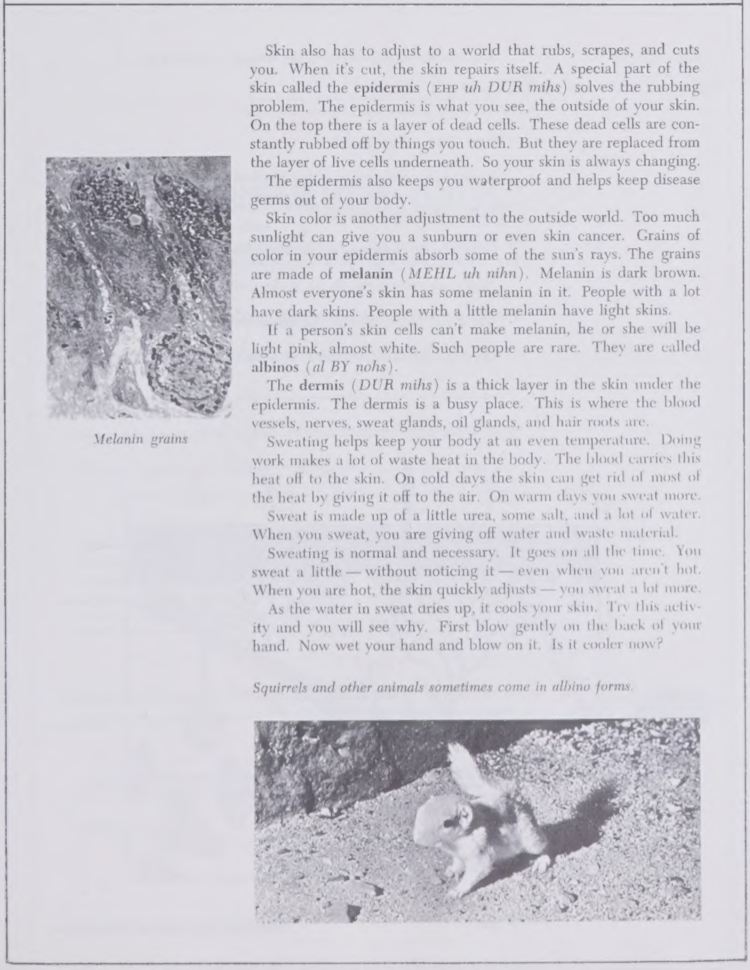


Skin also has to adjust to a world that rubs, scrapes, and cuts you. When it's cut, the skin repairs itself. A special part of the skin called the **epidermis** (EHP *uh DUR mihs*) solves the rubbing problem. The epidermis is what you see, the outside of your skin. On the top there is a layer of dead cells. These dead cells are constantly rubbed off by things you touch. But they are replaced from the layer of live cells underneath. So your skin is always changing.

The epidermis also keeps you waterproof and helps keep disease germs out of your body.

Skin color is another adjustment to the outside world. Too much sunlight can give you a sunburn or even skin cancer. Grains of color in your epidermis absorb some of the sun's rays. The grains are made of **melanin** (*MEHL uh nihn*). Melanin is dark brown. Almost everyone's skin has some melanin in it. People with a lot have dark skins. People with a little melanin have light skins.

Melanin grains

If a person's skin cells can't make melanin, he or she will be light pink, almost white. Such people are rare. They are called **albinos** (*al BY nohs*).

The **dermis** (*DUR mihs*) is a thick layer in the skin under the epidermis. The dermis is a busy place. This is where the blood vessels, nerves, sweat glands, oil glands, and hair roots are.

Sweating helps keep your body at an even temperature. Doing work makes a lot of waste heat in the body. The blood carries this heat off to the skin. On cold days the skin can get rid of most of the heat by giving it off to the air. On warm days you sweat more.

Sweat is made up of a little urea, some salt, and a lot of water. When you sweat, you are giving off water and waste material.

Sweating is normal and necessary. It goes on all the time. You sweat a little — without noticing it — even when you aren't hot. When you are hot, the skin quickly adjusts — you sweat a lot more.

As the water in sweat dries up, it cools your skin. Try this activity and you will see why. First blow gently on the back of your hand. Now wet your hand and blow on it. Is it cooler now?

Squirrels and other animals sometimes come in albino forms.

ABOUT THE PROGRAM

Who is the Program For?

Life: Activities and Explorations is a biology program for non-academic or underachieving students. It works well not only with students who lack verbal, mathematical, and scientific skills, but also with students who lack motivation. The basic approach is to involve students directly in "hands-on" activities that are particularly interesting and relevant to them. There is, accordingly, a minimum of background reading.

Organization of the Program

Life: Activities and Explorations is organized around a series of hands-on activities, called *Explorations*. The Explorations are arranged in clusters; each cluster is introduced by a *Reading*. The Readings are brief, simple, and stimulating. Their main purpose is to start students thinking about a topic and to introduce a necessary minimum of technical terms required to study it. It is not necessary to do all of the Readings, but even including the technical vocabulary, they are at about a fifth-grade reading-level. As a result, they should not be uncomfortable for poor readers. The examples shown are on pages 301–302 [hardback edition (HE) pages 204–205].

Although this Reading is brief, it covers some key points about skin—including skin color—that will help students in the following Explorations. Notice the photographs illustrating the Reading. They are not only striking, but provide important data points.

Once students have completed the Reading, they move immediately into the Explorations and get actively involved: see pages 303–304 (HE pages 206–207).

Each cluster of related Explorations is followed by an informal quiz called *Check Yourself* (see page 306; HE page 208) and frequently by a *Research You Can Do* section that suggests interesting ways to pursue the topic in greater depth.

Underachieving students resist written tests, so each chapter ends with a *Use Your Wits!* section that substitutes a puzzle or a game for the conventional chapter test. These are not only fun to do, but permit students to show what they have learned in a non-competitive way. [See page 310; hardback users refer to Teacher's Edition (TE) page T-42.)

Through the Readings and Explorations, *Life: Activities and Explorations* covers all the major biological concepts required by a 10th grade biology syllabus. But emphasis is given to those subjects that have special interest and relevance for nonacademic and unmotivated students.

The primary goals of the program are to help students

1. develop and maintain a high degree of motivation with regard to both science and the learning process in general.
2. master fundamental learning skills, particularly the important scientific skills of observing, describing, quantifying, organizing data, predicting, testing, and generalization.
3. relate science concepts to the students' immediate concerns, interests and experience.
4. develop a more positive self image and a higher degree of confidence in themselves and in their ability to handle schoolwork.
5. identify and appreciate their individual abilities and aptitudes, and the interests of others.
6. be aware of themselves as organisms in a community of organisms sharing a closed ecosystem.
7. develop a sensitivity to the environment and an appreciation of life in all its forms.

Exploration
4. The Skin

Old skin cells peel off human skin and are replaced by the cells below. × 100

TODAY YOU will take a closer look at your skin. You will learn how it is built to help it work for you.

Part One The Surface

The epidermis does not look the same all over. Describe the epidermis at these places on your body:

The epidermis that helps the fingertips grip an object ________

____

The epidermis that allows the knees and knuckles to bend ________

____

The epidermis that lets you see through the pupil of your eye ________

____

The epidermis that protects the bottom of your feet ________

____

Part Two The Inside

Look at this diagram of a tiny piece of skin. Notice the thickness. Use a blue pencil to color the sweat glands and the tubes leading to the openings in the skin.

What are the openings in the skin called? ________

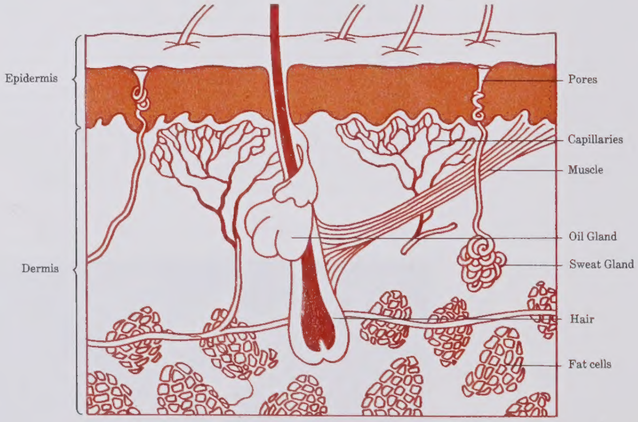
How many sweat glands are in the picture? ________

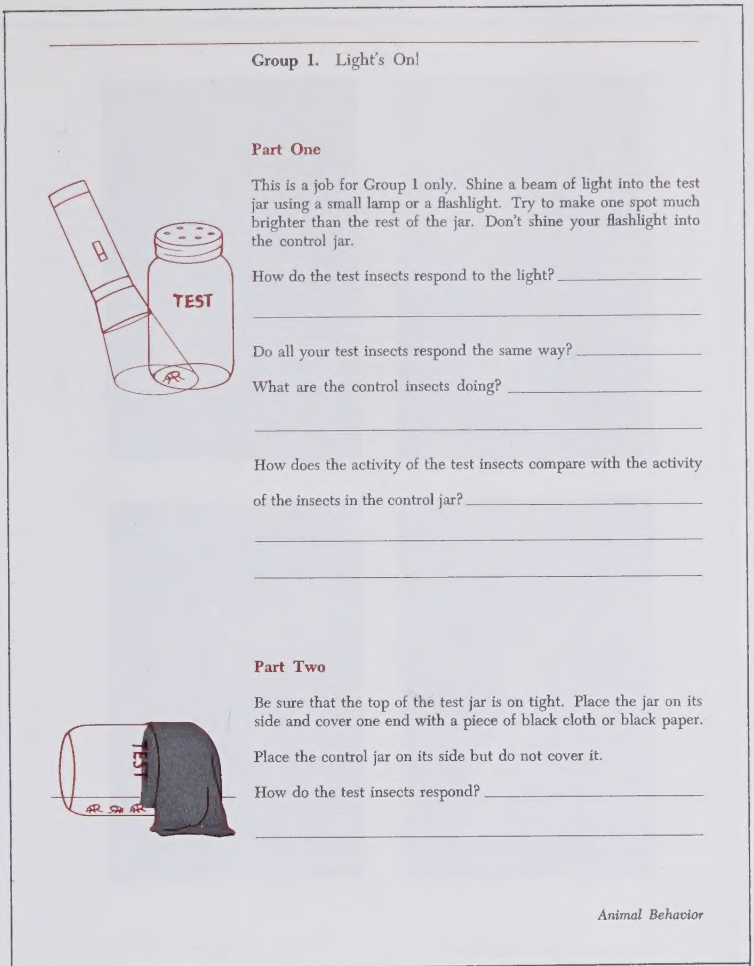
Use a red pencil to color the blood vessels near the sweat glands.

Why are the blood vessels so close to the sweat glands? ________

____

____





Group 1. Light's On!

Part One

This is a job for Group 1 only. Shine a beam of light into the test jar using a small lamp or a flashlight. Try to make one spot much brighter than the rest of the jar. Don't shine your flashlight into the control jar.

How do the test insects respond to the light? ______

______

Do all your test insects respond the same way? ______

What are the control insects doing? ______

______

How does the activity of the test insects compare with the activity of the insects in the control jar? ______

______

______

Part Two

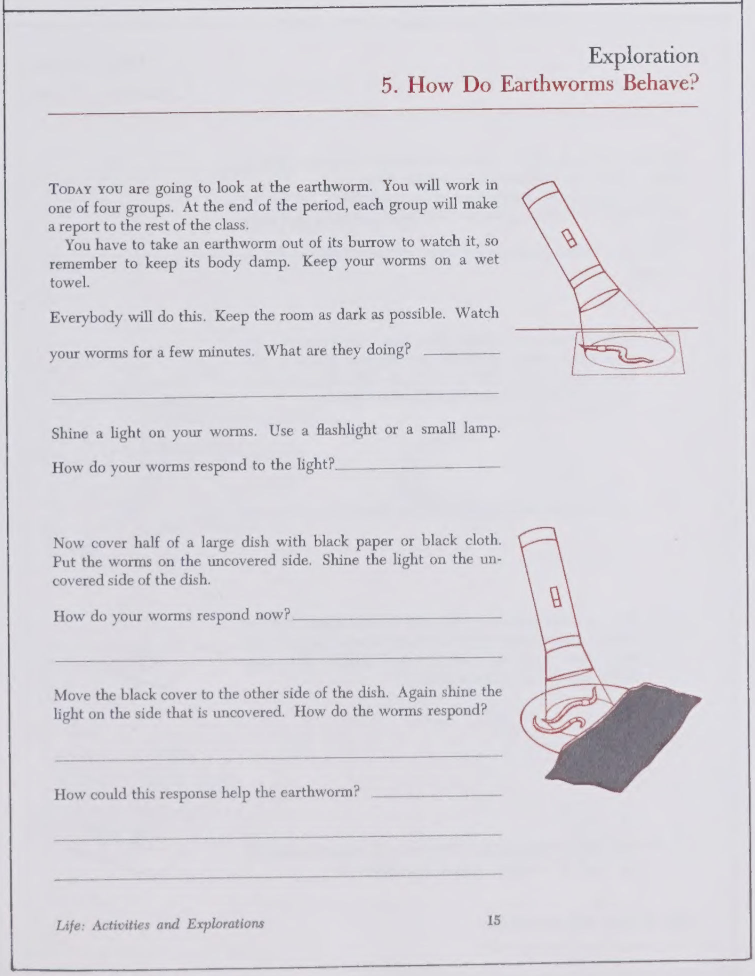
Be sure that the top of the test jar is on tight. Place the jar on its side and cover one end with a piece of black cloth or black paper.

Place the control jar on its side but do not cover it.

How do the test insects respond? ______

______

Animal Behavior



Exploration
5. How Do Earthworms Behave?

Today you are going to look at the earthworm. You will work in one of four groups. At the end of the period, each group will make a report to the rest of the class.

You have to take an earthworm out of its burrow to watch it, so remember to keep its body damp. Keep your worms on a wet towel.

Everybody will do this. Keep the room as dark as possible. Watch your worms for a few minutes. What are they doing? ______

______

Shine a light on your worms. Use a flashlight or a small lamp.

How do your worms respond to the light? ______

Now cover half of a large dish with black paper or black cloth. Put the worms on the uncovered side. Shine the light on the uncovered side of the dish.

How do your worms respond now? ______

______

Move the black cover to the other side of the dish. Again shine the light on the side that is uncovered. How do the worms respond?

______

How could this response help the earthworm? ______

______

______

Life: Activities and Explorations 15

FEATURES OF THE PROGRAM

Doing and succeeding

The basic philosophy of *Life: Activities and Explorations* is that students are best motivated when they are directly involved in activities. More than 70 Explorations provide the backbone of the program. It is important for these students to succeed in what they attempt. They have generally become all-too-accustomed to failure; most of them anticipate it. It is vital to break their string of failures. The Explorations have been designed to give every student at least some measure of success. The Exploration that begins on page 8 (HE page 7) is typical.

The students study stimulus-response behavior in living insects that they collect themselves. The directions for the activity are clear and easy to follow; marginal diagrams parallel the printed directions to help non-verbal students. The students immediately learn the importance of experimental controls. They learn also to observe and to record their data. And because they record *their own* observations, they do not have to contend with a "right-or-wrong" situation.

Another Exploration, similar in design, appears on page 15 (HE page 12). Here the students work with earthworms. This pattern of repetition, typical of key Explorations, has several functions. First, it allows students who have tackled the earlier activity to practise and improve the skills they have already acquired. Second, it gives them a chance to extend their knowledge and experience. Third, it makes sure that no student (and many of these students are chronic absentees) misses an important concept and an opportunity to develop vital skills and information.

Seeing the way

Many students today would rather get their information from pictures than from reading. This is particularly true of students who are not skilled readers, but who often have a high level of visual sophistication. *Life: Activities and Explorations* has been designed to meet their needs. The Readings are illustrated with intriguing and often striking photographs. Other photographs, sprinkled throughout the book (for example, page 29, HE pages 20–21) extend the content of the Explorations or provide data for them. In addition, clear and simple illustrations in the margins are frequently used to duplicate printed directions. In an example from Chapter 5, page 175 (HE pages 115–116), students learn how to prepare a microscope slide. Notice how closely the diagrams follow the sequence of verbal instructions—another "fail-safe" feature of *Life: Activities and Explorations.*

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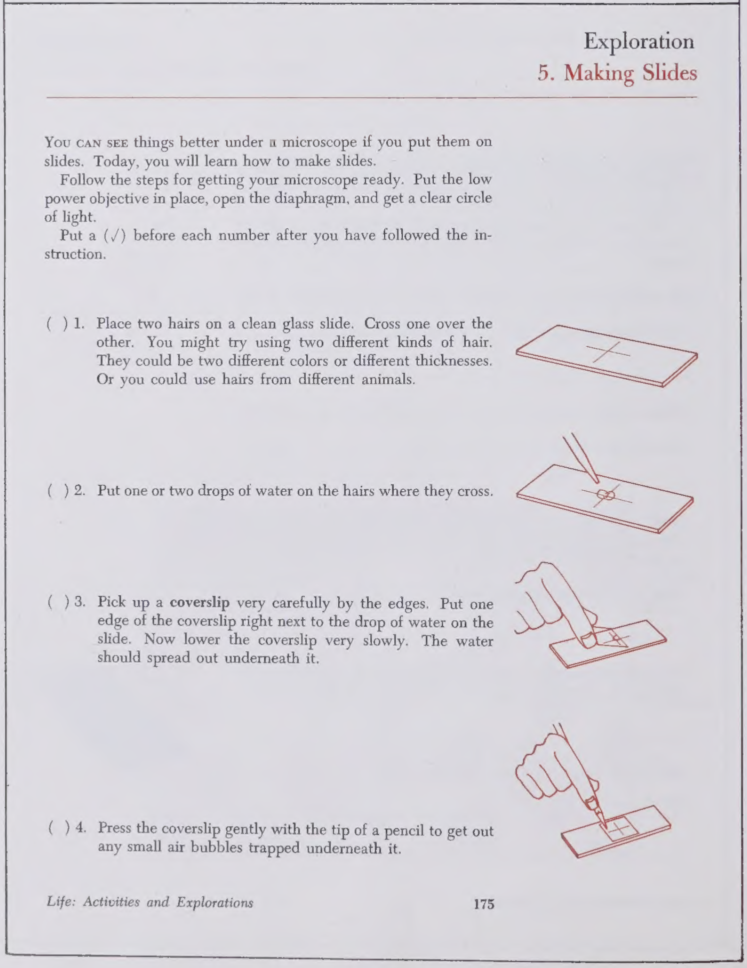

Exploration

5. Making Slides

You can see things better under a microscope if you put them on slides. Today, you will learn how to make slides.

Follow the steps for getting your microscope ready. Put the low power objective in place, open the diaphragm, and get a clear circle of light.

Put a (✓) before each number after you have followed the instruction.

( ) 1. Place two hairs on a clean glass slide. Cross one over the other. You might try using two different kinds of hair. They could be two different colors or different thicknesses. Or you could use hairs from different animals.

( ) 2. Put one or two drops of water on the hairs where they cross.

( ) 3. Pick up a **coverslip** very carefully by the edges. Put one edge of the coverslip right next to the drop of water on the slide. Now lower the coverslip very slowly. The water should spread out underneath it.

( ) 4. Press the coverslip gently with the tip of a pencil to get out any small air bubbles trapped underneath it.

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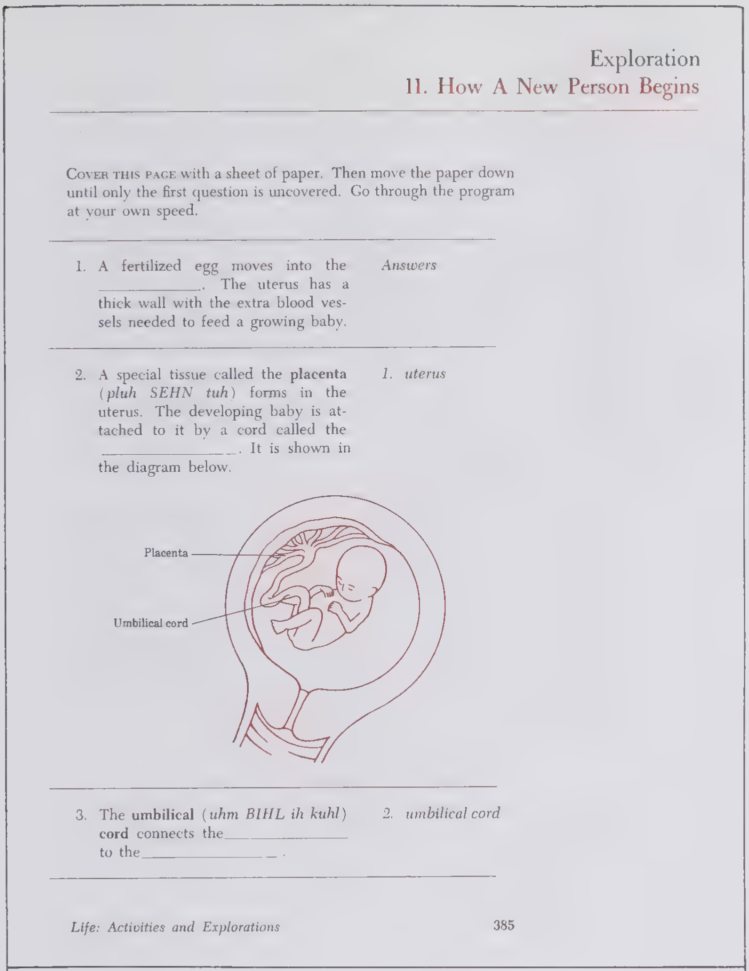

Exploration
11. How A New Person Begins

COVER THIS PAGE with a sheet of paper. Then move the paper down until only the first question is uncovered. Go through the program at your own speed.

	Answers
1. A fertilized egg moves into the ____________. The uterus has a thick wall with the extra blood vessels needed to feed a growing baby.	
2. A special tissue called the **placenta** (*pluh SEHN tuh*) forms in the uterus. The developing baby is attached to it by a cord called the ________________. It is shown in the diagram below.	1. *uterus*
3. The **umbilical** (*uhm BIHL ih kuhl*) **cord** connects the______________ to the______________.	2. *umbilical cord*

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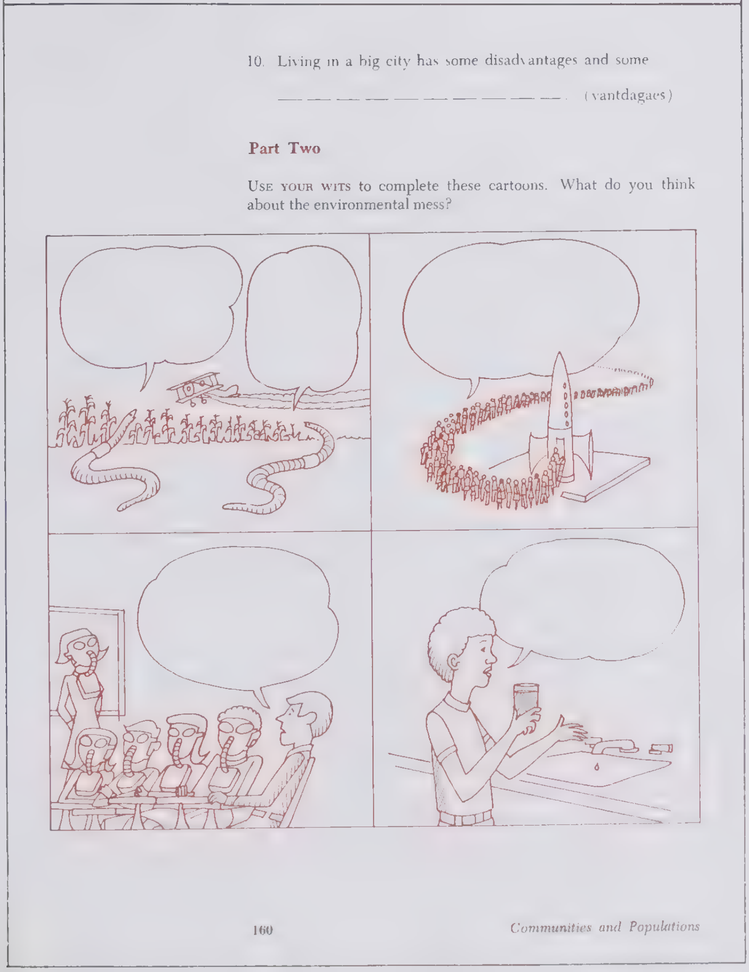


10. Living in a big city has some disadvantages and some
__ __ __ __ __ __ __ __ __ __ . (vantdagaes)

Part Two

USE YOUR WITS to complete these cartoons. What do you think about the environmental mess?

160 *Communities and Populations*

Getting motivated

Lack of motivation is characteristic of many of the students who take this program, so a variety of substantial motivating factors have been built into *Life: Activities and Explorations*. We have purposely avoided comic book formats and other condescending gimmicks that are of doubtful effectiveness in engaging the students' interest. From the beginning, students work with living organisms and laboratory equipment, something they have probably not been allowed to do to any great extent previously. Topics have been chosen for their immediate interest and relevance to the students' own lives and backgrounds. The last two chapters deal with health, with a major emphasis on teenage problems and concerns. Three Explorations in Chapter 12, pages 379 ff. (HE pages 259 ff.) deal with a subject of great concern to students at this stage of their development, human reproduction. The Explorations are in a programmed format, as shown.

Another important motivator is the "build-your-own-book" feature. As students complete the pages of the consumable edition or the Laboratory Supplement accompanying the hardback edition, they put them in a three-ring binder and accumulate their own "textbook" as they progress through the program. Pages are punched and perforated to make the process simple and almost automatic.

The two appendixes, pages 475–481 (HE pages 333–343) will interest most students. The first, *Careers in Health*, gives them some relevant information about opportunities in the growing health field for both non-college bound and college-bound students. The second, *Biology Hall of Fame*, is a gallery of men and women from many national, cultural, and ethnic backgrounds who have made important contributions to the life sciences.

And finally, many of the activities in *Life: Activities and Explorations* are simply fun to do. This is particularly true of the *Use Your Wits!* quizzes like the one on page 160 (TE page T-37), which replace the traditional end-of-chapter tests with puzzles and games.

Introduction

Who Will Use *Life: Activities and Explorations*?

The usual approach to teaching biology to the so-called slow learner, educationally disadvantaged, or underachiever is to present a watered-down version of the same material taught to the college-bound student. The fact that the needs, interests, and abilities of nonacademic students may be very different from those of college preparatory students is for the most part ignored. Although such students are not academically oriented, they are expected to read the same textbook as their college-bound classmates. They are not, however, allowed to handle laboratory materials because the teacher fears that they might break or otherwise damage equipment. As a result the biology course, planned in good faith, often becomes in practice one in which the teacher lectures and the student listens or daydreams.

Who are the slow learners, the underachievers, the educationally disadvantaged? By school standards these are the students who are unsuccessful. They have poor work habits and earn poor grades. They regard themselves as failures. They lack confidence in themselves and have lost their incentive to learn. To them, school is uninteresting, often unpleasant, and usually unrelated to their lives and interests.

Most of these youngsters have done poorly in school since the elementary grades. With each passing year, they fall further and further behind in their school work. As a result, they become more and more frustrated with the entire school experience.

Some estimates place the number of nonacademic students at 15 to 20 percent of the school population. The largest number live in the inner cities. But a substantial number also live in the suburbs. Economic, racial, and social problems are some of the reasons why these children fail in school. In some cases, psychological or emotional disturbances add to their problems.

At the high school level these students generally show two patterns of behavior. Some are aggressive. They disrupt classes and antagonize school personnel. They may be responsible for much of the vandalism in schools. Others withdraw. They become disengaged. They tune out the teacher and all learning experiences.

Such students tend to drop out of school early. When they come to school, they arrive late, forget their materials, study the wrong assignment, and don't participate in classroom discussions. It is not unusual to find 8 or 10 students absent from a class of 30. Many are bounced around from class to class in an effort to place them in the proper academic track. Or they bounce from school to school as their families move, or they are transferred for "administrative" reasons.

Most are deficient in reading and writing skills and noticeably limited in verbal skills. They find it difficult to express themselves. They often do not ask questions as an aid to learning, and will hide behind an "I don't know" rather than risk being wrong.

Most of these students, however, possess the ability and the potential to perform at a higher level. They can learn. When they are exposed to sympathetic teaching techniques, excellent materials, relevant curricula, and effective teachers, the students' self-esteem, as well as their school work, improves. *Life: Activities and Explorations* grew out of our frustration in trying to modify a college preparatory course to fit the needs of nonacademic students. The following are some of the types of students we were attempting to reach.

Willie came to school once or twice a week. When he attended class, he spent his time drawing spacemen and soldiers wearing pointed helmets. He carried a pad that he used for his drawings and, because it was quite full, it seemed that he spent his entire school day in this activity. He was detached from the class activities and only rarely participated or contributed to the group. He was disinterested in using his talent to make charts or drawings that could be used to supplement class work.

The day the class started to work on plant behavior and set up the "seed sandwich" to show responses to gravity, Willie was absent. When he returned to school, the seeds belonging to his partners had started to grow. He was fascinated by the germinating seeds and asked if he could start an experiment of his own. The material was made available to him and for the first time he became engrossed in a class activity. The Explorations that followed—plant responses to light, to water, and to touch—continued to hold his interest. He appeared in class every day, checked and watered his seedlings, and called the attention of the teacher to every new change that he observed. His drawing pad remained untouched as he developed a record of the observed plant behavior.

When the experiments were completed, Willie was reluctant to discard what remained of the plants and transferred them to pots of soil. The developing lentil and bean plants were his pride; he was very careful about seeing to their needs over the weekends.

When the class moved into the next unit, Willie moved right along with them. His main interest, however, continued to be his plants.

Unexpectedly, Willie came to class one day with an administrative order that transferred him to another school in the same city. Apparently he had demonstrated a more violent side of his nature elsewhere in the school.

He refused to take his plants with him when he left.

Martin had been in the program for three or four months and was doing very well. His family then moved and he had to transfer to another high school. As he signed out of the biology class, he said to the teacher, "Boy, this is the first time I've had a class that I really like, and now I have to leave it!"

José had been in a bilingual program in junior high school and had managed to perform well. Now, in 10th grade, he was overwhelmed by being expected to handle his school work entirely in English. He was unable to cope and unwilling to try. In an attempt to help, we placed him at a lab table with a Spanish-speaking student who could read English fairly well. Gradually, José was encouraged to do the laboratory work but he would make no attempt to record his results. No pressure was put on him. When the class turned in an Exploration, José was asked to turn in his blank papers. They were regarded as acceptable if he had done work that was acceptable.

When José answered a question orally, even if it was merely "yes" or "no," he was asked to put the same answer on his paper. It was weeks before he felt secure enough to answer a question without being coached or coaxed. At long length (about half of the school year had passed) he began to record his results in his own version of the English language. He continued to rely on his partner, however, to translate some of the directions.

Terry was transferred after Christmas into a class using this program. This was her third biology class and third teacher. She had been assigned in error to a college prep class that was using a textbook she couldn't handle. She had fallen behind and was troubled and disruptive. When she was shifted into the second class she was unable to settle into the work. The class was in the middle of a topic and she felt out-of-step.

When she entered the third class, Terry did not have the burden of make-up work put on her. She was able to step in and work with the class right away. At first she depended on her neighbors for her written answers. Soon, however, she began to handle each Exploration with confidence. She enjoyed being told that she had done a good job and was especially tickled when she got extra credit for asking a good question. She began to greet the teacher with "What are we doing today?" and was ready to tackle whatever it might be.

How Does *Life* Work for the Nonacademic Student?

The major objectives of *Life: Activities and Explorations* are: to provide opportunities for young people to think, to inquire, to become familiar with relevant topics in biology—and most of all, to succeed. We incorporate instructional matter that is functional and important to the students, their problems, and their world. For example, there are topics on health care, pollution, nutrition, human behavior, and human reproduction. In addition, there are games and puzzles to add excitement and interest.

The program begins to build at an elementary level, and is structured so that less than perfect results are acceptable. The small amount of reading material is of high interest and low readability. There are few technical terms, relatively little biochemistry, and very little mathematics.

We want students to see a reason for coming to class. And then we want them to feel a sense of personal worth. As the course progresses, we hope that their skills in reading, writing, and mathematics will improve along with their ability to express themselves—not because they are in school, but rather because they will be self-motivated. These skills include observing, organizing data, computing averages, making predictions, and learning to handle special equipment.

The text is designed to help students learn to follow directions. Many of the instructions for activities are set up verbally and pictorially. As an example look at Chapter 11, "The Frog and You." These are not just good pictures, but accurate photographs to help students carry out the Exploration. We believe students should attack a problem in a rational manner, and find their own solutions rather than be spoon-fed directions and answers by the teacher. Learning to listen to each other as well as to the teacher is a major achievement for the skill-deficient, the unmotivated, the tuned-out student.

The program maintains student interest and motivation by a combination of factors—by the use of living materials, by the informal laboratory atmosphere, and by active involvement rather than passive listening. Encouragement and praise from the teacher for each small success motivates members of the class to take another step forward. Since the approach centers on the methodology of science and not its content, students are not pressured by the need to complete a predetermined amount of material. They should be permitted to set their own pace.

These young people are only a few years or so away from adulthood and the decisions and responsibilities it involves. They are growing up in a world increasingly more concerned with problems of environmental pollution, overpopulation, poverty, health, war, prejudice, drug addiction, and nutritional deficiencies. This will be a world desperately in need of well-educated and clear-thinking people.

How our students fit into this emerging society as they mature depends in large measure on their educational experiences. *Life: Activities and Explorations* is designed to help students achieve a better understanding of the processes of science, but also to improve their attitudes toward themselves and their society.

How Is the Student Text Used?

Life: Activities and Explorations is organized into units consisting of *Readings* and related *Explorations*. The Readings are short, easy to read, and to-the-point. Besides giving students background information they will need, the Readings stimulate curiosity or interests in a particular topic. A Reading may introduce one Exploration or several Explorations.

All basic biological concepts are covered in the Explorations. These are activities and experiments that give the students "hands-on" learning experiences. As the students go through a chapter they encounter *Check Yourself* sections which encourage them to review what they have learned to date. Each chapter ends with a *Use Your Wits!* section that consists of a review of key chapter contents in the form of a game or puzzle. Other features include *Careers in Health* and a *Biology Hall of Fame.*

Readings

The Readings can be read aloud in class. If you choose this approach, some students will like to read aloud, some will be reluctant, and a few will refuse. Don't insist that everyone read because it is usually the poor readers that beg off to avoid embarrassment. Perhaps later in the year they will be more willing to read

As an alternative, you can have the students tape record all or some of the Readings. Try to have each student record at least one Reading on tape. Some may wish to work in groups. The students will enjoy the tape sessions and at the same time gain some confidence in their verbal skills. Moreover, listening to a tape is one way to review a lesson.

Before you start an Exploration play the tape for the related Reading to the entire class. The tapes can be used by small groups also, and students who have been absent can listen to the tapes with earphones.

If your students show signs of resistance to using the Readings as designed, you may go directly to the Explorations. Note, however, that if you do this it will be necessary to explain the needed background information and vocabulary to the class before starting the Exploration. Keep your explanation as brief as possible, and encourage the students to refer to the Reading during and after the Exploration.

Resist the natural impulse to spend a lot of time on the Readings. They are designed to set the stage for the following Explorations, and should not be extended to the point that your students become bored or otherwise disaffected.

Explorations

The Explorations constitute the heart of the course. There are more than 70 activity-oriented Explorations for students to do.

The teacher and class should decide those Explorations that will be covered during the course. This may be difficult early in the year. The Explorations STARRED in the Table of Contents make up the core of the program. Decide whether all or only representative activities will be used in each chapter. Keep in mind the scheduled time allowed for the course, because there is more material than can be completed in a 180 day school year. One to three days are needed to work through most of the Explorations.

The Explorations have been planned as inquiry; they are designed to be self-contained units in which the students find their own answers. Students should not be afraid of making mistakes. They can learn by being wrong occasionally, and in fact should be encouraged to value results that are unexpected or different from their neighbors' results. There are no "give away" answers. Since many of the questions ask "What do you think?" the students can hardly be wrong no matter what their response.

Each activity is self-contained, and does not depend on any previous activity. Thus, while students who have been absent lose some of the continuity of the course, they can join the class at any point and do the next activity without feeling completely left out.

For most of the Explorations we recommend that you divide the class into small groups. Let each group work alone. The members of the group can then discuss and exchange ideas with each other. Stay in the background as much as possible, but circulate, observe, and question what is going on. Be prepared to help as needed.

Before the class meets, set out trays of materials for each Exploration and label the trays so the students can pick up their materials as they come into the room. The instructions at the beginning of the Exploration in the Teacher's Edition will indicate whether the material is the same for all groups. Usually it is. If it differs, however, there is a separate list of materials for each tray as well as a general list to help the teacher prepare for the class. Identifying numbers (or symbols) on the trays will help with the housekeeping and checking of materials at the end of the period. A student aide might be appointed or elected to set up the trays each day and then help put things away.

When a pencil is listed as the only needed material, it means that writing, rather than manipulating equipment, is the activity for the day. These pencil labs are exercises in thinking, in interpreting information, in following directions, and sometimes in collecting data. They are not busy work, and should not be regarded as such.

Making Their Own "Biology Books"

Because so many underachieving students lose or forget their books, it is suggested that the student texts be kept in classrooms. The pages in the soft cover text are perforated and punched, and can be torn out as they are needed. When each Exploration has been completed, it should be reviewed and checked. (See page T13 for a discussion of evaluation techniques.) You might record the marks or activities completed on a chart displayed in the classroom. Seeing a mark or noting progress sometimes serves as an immediate reward for students who have done a good job. On the other hand, chronic absentees are reminded that they miss something when they are not in school. The time needed for the teacher to check papers is minimal. Often this can be done as the class is observed at work. Good work should always be commended. This is important because these students seldom experience the satisfaction of achieving. An activity in *Life* may be the first time all day or all week they were able to "do something right."

As the Explorations are completed, each student should file his or her activity sheets sequentially in a folder or three-ring binder clearly labeled with the student's name. These should be stored on a shelf within easy reach. Those classes using the hard cover text should also obtain folders or binders to store notebook records of the Explorations. The students create their own texts by filing their completed work as the course progresses. Because they are creating their own books, they are encouraged to do the best job possible with each Exploration. This continuing creative activity is a source of great satisfaction for many students. If the students are told at the beginning of the year that the "book" will be theirs to keep at the conclusion of the course, they will often devote much more effort to its creation.

Other Learning Activities

Use Your Wits and *Check Yourself* sections in each chapter turn chapter reviews into puzzles and games. Students can recall and synthesize what they have learned without feeling they have a test to pass.

Research You Can Do sections may include doing an experiment or looking up information in another book. These sections provide directed optional activities for the more capable or interested students. Occasionally, when a special idea or concept is introduced, the Research should be done by the entire class. Some of the most exciting illustrations are in the Research sections. These are meant to motivate the class to do extra work. An extra mark or points is an immediate pay-off for the extra work.

The *Biology Hall of Fame* reports on men and women who have made major contributions to life science and society. Some students may want to give more in-depth reports on these famous biologists.

Careers in Health are described in the appendix. Health care and related services offer a number of interesting vocational possibilities to students who don't expect to go to college. This section and the Hall of Fame can be used by the imaginative teacher to enrich the students' backgrounds. There are occasionally blocks of time to be filled, especially when waiting for plants to grow.

Teaching Tips

If you are to work well with these students you must be friendly and show a personal interest in what they are doing. Recognize them as individuals who can do worthwhile things. Hold the students to their individual best and not their least efforts. And most important . . . listen to them.

In the classroom you can use a variety of teaching techniques and materials. Get your students heavily involved in meaningful activities in which they make individual inquiries for themselves. Don't ask them to memorize anything; instead, encourage them to observe, guess, think, and experiment. Ask carefully worded questions to stimulate student discussions, to find out what the students know, and to lead the students to new ideas and concepts. You should be prepared to accept all answers to questions as worthwhile contributions. In this way, the students discover that there isn't just one answer—or even one "correct" answer—to everything.

In this course, much of the activity is planned for small group work within the class. Sometimes there is a sharing of responsibility in order to get a job done. At other times it is more practical to share equipment. Allowing underachieving students to work in groups may be a bit uncomfortable for you at the start. We have found, however, that discipline problems are generally minimized when small groups work together. Each student has something to do every day; it usually is something in which he is interested.

Starting the course slowly so that all of the students will be successful is a key part of this program. In time the students will respond to more challenging tasks. You should not rush through or try to cover too much. It is more important that the students succeed in what they are doing. Only by succeeding will they be motivated to do more.

When you provide a classroom environment that is friendly, a course that allows students to handle equipment, to make observations, and to think, and an evaluation system that calls for success rather than failure, then your classroom becomes an important and pleasant place to be.

Two or three times during the school year you may want to evaluate your own performance as a classroom teacher. The following is a sample scorecard you might use. Note that it lists key behaviors that establish and reinforce mutual respect and understanding between the teacher and his or her students. How do you rate? Try to make a quantitative judgment. Count the number of times you find yourself employing each technique. Try rating yourself qualitatively *before* teaching an Exploration or chapter, and then rerate yourself quantitatively after teaching. You may wish to rate yourself by answering each question with *none of the time, some of the time,* or *most of the time.*

In my teaching do I:

1. provide opportunities for everyone in class to reach their goals?
2. take a personal interest in all students?
3. praise students when they do well?
4. have a sense of humor?
5. guide students during an activity?
6. provide positive reinforcement?
7. maintain a classroom environment of mutual respect and patience?
8. call students by their first names?
9. listen to what students have to say?
10. identify individual capabilities?
11. accept conclusions students reach from doing an activity?
12. allow enough time for all students to do activities?
13. project a personality that is firm but not harsh?

Evaluation Techniques

We do not believe that conventional written progress tests are successful with underachieving students. Such tests usually have a negative effect and simply extend and reinforce the problems underachieving students already have. Thus, it is not appropriate in this program to use formal testing. Instead, we would like to offer the following suggestions to help you evaluate student progress.

Student Evaluation Scorecards

We suggest you use the following ideas and scorecards during the year to evaluate your students. Blank models of some of these scorecards are provided at the end of this section.

(1) As soon as you can, familiarize yourself with the background and personality of each student. Try to get to know each one as a person. Your guidance department may be able to help. Find out about family background, strengths and weaknesses in terms of skills and temperament, and potentially limiting factors. Keep a file for each student. Update the file, and review it periodically. Try to maintain friendly relations with your students. It may be weeks before some accept you as a friend. Others will establish a rapport in the first few days. And there may be some who will not accept you at all.

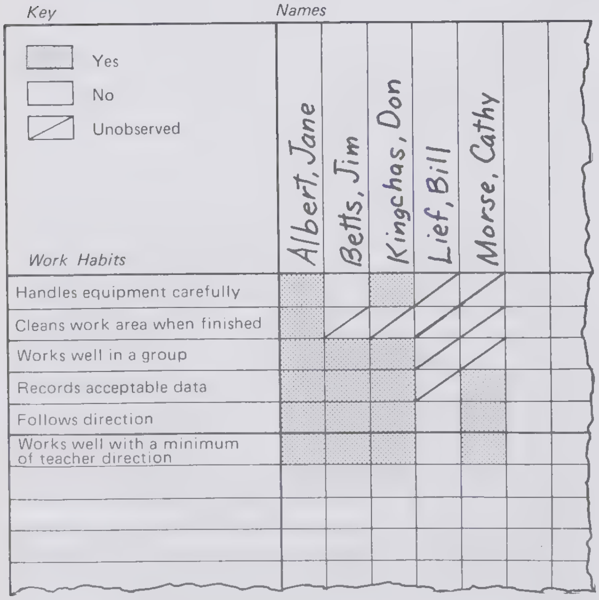
By assessing student characteristics at the start of the year you can begin to plan effective learning experiences. In some schools, for example, reading scores are made available to classroom teachers. Moreover, your observations will help you judge pupil growth in several areas throughout the year.

(2) During the first several Explorations of the school year you should observe your students to obtain some feedback on their attitudes, interests, and skills. How well do they read and write? Do they take easily to laboratory experiences? Can they work in groups? How well do they organize materials?

The following scorecard can be used to check your students' growth in work habits. Use it several times during the course to evaluate work habits as the students carry out Explorations.

Identify the types of work habits you feel are important in the program and check the progress of just a few students at a time.

This is an example of a scorecard for a small group of students working on a given Exploration. To make the task easier try to repeat the list of work habits several times on the students' scorecard (see sample on page T23). This will allow you to evaluate your class's work habits three or four times during the year using a minimum number of scorecard sheets.



Key

▨ Yes
☐ No
⧄ Unobserved

Names

Work Habits	Albert, Jane	Betts, Jim	Kingchas, Don	Lief, Bill	Morse, Cathy		
Handles equipment carefully	▨		▨	⧄	⧄		
Cleans work area when finished	▨	⧄	⧄	⧄	⧄		
Works well in a group	▨	▨	▨	⧄	⧄		
Records acceptable data	▨	▨	▨	⧄	▨		
Follows direction	▨	▨	▨		▨		
Works well with a minimum of teacher direction	▨	▨	▨		▨		

A chart of this type need not be displayed, although each student's growth in work habits should be discussed in private with the student.

(3) The behavioral objectives listed at the beginning of each Exploration constitute the major evaluative tool of the course. These objectives describe the behaviors the students are expected to exhibit as they master each Exploration.

The minimum requirement of the course is to have students achieve some mastery of the behavioral objectives given for the STARRED Explorations or Readings. (See reproduced student text Table of Contents, pages T73ff., Teacher's Edition.) The starred Explorations or Readings require approximately 116 days of school work. Therefore, there is ample time during the year to reteach and rework activities as needed so that all students can achieve the minimum requirements.

We recognize that you will probably be required to issue grades. Any grades assigned should take into account the student's work habits, class participation, any extra assignments done, and achievement of the behavioral objectives. The degree of the student's interest, involvement, and enthusiasm should also weigh heavily in your grading. Grading should not be punitive in this course (or any other course, for that matter), and you should make an honest effort to provide ample learning opportunities for all students to achieve the minimum requirements for a passing grade.

You can use a special scorecard such as the one shown to record the student's level of mastery of objectives. The objectives given are for the Exploration "How Do Earthworms Behave?" When a student has thoroughly mastered a behavioral objective, completely color in the appropriate square next to his or her name. If a student achieves partial mastery of an objective, color in a half-square. Leave the square blank for incomplete work.

In order to complete the scorecard you will have to observe the students as they work. Are they demonstrating mastery of the objectives? Do the answers on their worksheets or in their notebooks indicate mastery? To evaluate students who cannot read or write well, work with them individually. Draw out what they know. They may not be able to write answers but they may be able to demonstrate mastery orally. Maybe they can sketch their results. Written, oral, or graphic answers are equally acceptable.

Each Exploration takes approximately one to three days to complete. Fill in the scorecards as the Exploration progresses.

The following is a sample score card for a group of students who have worked on an Exploration for three days. You may want to duplicate the sample on page T24 or develop your own form. A standard class register book can also be adapted for this purpose.

Chapter One Exploration Five. How Do Earthworms Behave?

Objectives

After completing this Exploration, the students will be able to

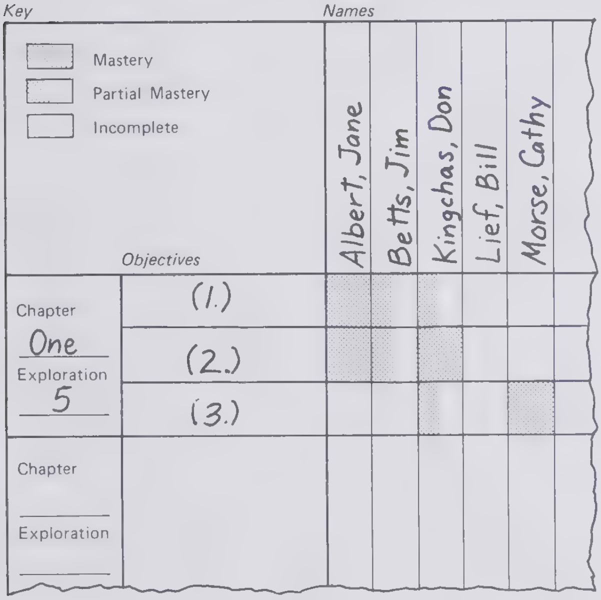
(1) observe and record earthworm responses to various stimuli.

(2) correctly answer questions about inborn behavioral patterns of earthworms.

(3) explain the survival value of one or more of the earthworm's responses.

When you review the scorecard, you will see certain patterns. For example, Don appears to be a steady worker. He is the only one who has completed all the objectives. Even though he showed only partial mastery on two objectives, he should be praised for work well done.

Jane completed two objectives, but was incomplete on her third one. Try to find out what went wrong. She may not have completed the activity, or she may be having difficulty recording her results. Help her to complete the activity.



Cathy was absent for two days and completed only Objective 3. This was the most difficult of the objectives. She may have the capacity to do good work when she is in school. Indeed, Cathy's problem may be that she is constantly absent from school. Check her attendance records. If she is an habitual absentee, encourage her to come more often. Success may well be all the encouragement she needs.

Jim achieved partial mastery on two assignments. He was absent for the other. He appears to be the type of student who will probably complete the assignment when he comes back to school. He may be the so-called "average" student in the class.

Bill was absent during one activity and was unable to complete his work on two other objectives. Is this a personality problem or a skills problem? He may be antagonistic toward school. He may daydream a lot. He may not like his group. Or, he may be uninterested in this particular activity. On the other hand, he may be trying, but is unable to complete his work. By observing Bill and by checking his personal file you should be able to find out what his problem is. He may need more personal contact with his teachers. Try to find out what he can do. You may have to rewrite some of the objectives to fit his needs. Give him the opportunity to do the activities again and to succeed with the objectives.

In this program there should be no punishment for incomplete or faulty work. It is important that you praise any effort or achievement consistent with the student's abilities. Consider displaying the student scorecard as a motivational device. Many students enjoy seeing a record of what they have achieved, as well as an indication of what they have missed, and perhaps will want to make up.

This chart shows that most students did not do well with Objective 3. It seems to be the most difficult for the group. You may need to reteach this activity so the students will succeed, although if the objective occurs again in a later activity you may move on. There are several ways you might reteach. (1) Use a parallel activity with similar objectives. (2) Repeat the activity with different organisms or materials so students do not feel they are merely repeating things. (3) Rewrite the difficult objective so that it is consistent with your students' abilities. (4) As a last resort, reteach the activity as it stands.

If your course is to be truly "success oriented," then a concentrated and genuine effort must be made to help students achieve those behavioral objectives they are not successful with the first time around. This is probably your greatest challenge with the underachiever. How you meet it will in large measure determine your success as a teacher with the academically turned-off student.

Additional Tips on Evaluation

(1) Evaluation techniques should provide feedback on what the individual student has learned or has not learned. Don't measure the performance of one student against another. Students are unique individuals. They have individual backgrounds, interests, and skills.

(2) Evaluation techniques should not be designed to fail students. Tests often fail those students who need to fail the least. It is important in this program that all students be successful if they come to school and are working up to their capacity.

(3) Evaluation techniques should be continuous and cumulative. If possible, permit students to take an active role in evaluating themselves. Self-evaluation helps students identify their strengths and weaknesses. You may want to combine their self-evaluations with your own evaluations.

The Big Day

Capture the interest of your students the first day they come to class by briefly explaining some of the exciting things they will be doing in *Life: Activities and Explorations.* Put the emphasis on the many activity-oriented materials in the program. Stress that there will be no big tests or quicky quizzes. Instead, there will be many challenging games and puzzles to do. And there will be a minimum of reading, too. Try to keep these introductory remarks to a minimum. Instead, move the class into an opening "hands-on" activity as quickly as possible. Here is one possibility.

This activity is designed to help students develop some concepts about living things and to kick off Unit One—How Plants and Animals Behave.

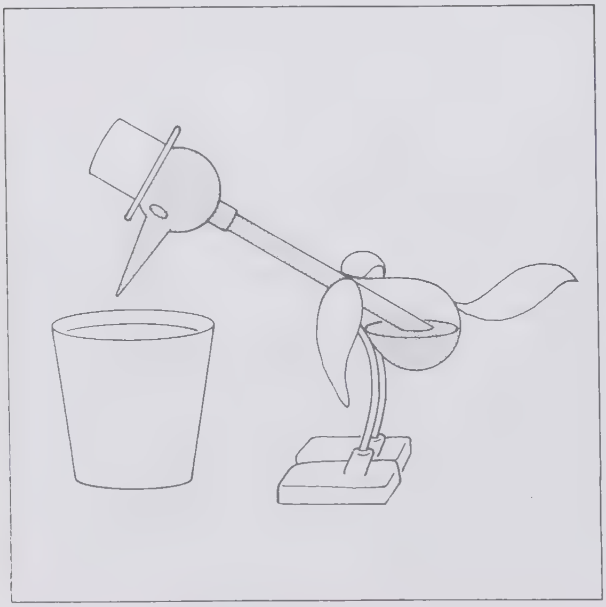
Prior to class, display the following items in different sections of the room. You may use substitutes. Set up several dishes containing seeds. Bring in one or more small organisms such as a gerbil, white mouse, aquarium fish, snake, or turtle. If possible bring in some caged small animals that are harmless, such as earthworms, ants, moths, or butterflies. Put a terrarium and several houseplants on a table. Try to set up a "living station" in several places throughout the room, four or five in all.

Put these headings on the chalkboard:

1. Name all the living things in this room.
2. How do you know they're living?

When the class meets, explain that you want to find out what they know about living things. After a short discussion divide the students into small groups. Place a group at each station.

Encourage them to make careful observations of the living things. Then have them write out their observations and the answers to the questions on the chalkboard. Each group can work together and compare notes. One chairperson could write up all the notes for the group. Every four to five minutes rotate the groups.



Circulate while the students work. Observe and listen to each student as he or she interacts with others. You can provide clues to questions if needed. But don't give any answers.

Bring the class together when you feel they have had enough time to observe all the living things in the room. Encourage each group to discuss their observations, and to write their ideas and comments on the chalkboard. If there is resistance to writing, encourage verbal responses instead. In addition, you should resist the impulse to correct or rephrase a student's contributions. And try to get as many students to volunteer as possible.

Don't try to reach any conclusions at the end of this first period. Ask your students to think over what they have done until the next session.

If it is difficult or impossible to set up the "living stations" for the first day in class a good alternate plan is to set up three or four "dunking birds" in the room (see illustration). Give the students time to write down everything they observe about the "birds' " behavior, and then ask, "What do we mean when we say something is alive?" Almost invariably, someone will volunteer the thought that if an object moves, it is alive. Use this idea to launch the discussion by asking "But are these 'birds' indeed alive?"

As the students consider this question, have them compare the characteristics of the mechanical bird with those of obvious living things—a dog, a horse, a person. If possible, have a living bird in the room for this lesson. The bird will provide a positive stimulus to draw the members of the class into discussion. Do not attempt in this activity to produce a definition of life. Instead, the activity should produce a list (in the students' own wording) of observable properties of living things, and hopefully also a list of questions the students would like answered during the course.

If dunking birds are not available, or if you are concerned about the students' ability to understand the physics of the mechanical bird's motion (the students will ask, this you may be sure of), you can substitute a handful of seeds. In this case, the basic questions are "Are the seeds alive?" and "How do you know they are alive?" Use the students' responses to launch the discussion of the properties of living things.

Begin the second session by rewriting the students' observations on the chalkboard. Ask them if anyone has anything to add or change. Then suggest that they start the first Reading, Stimulus → Response. Explain that this is concerned with one important characteristic of living things.

After the Reading you may want to discuss the students' observations as they relate to the Reading, or you can begin planning with the class for the activities, which will start on the following day.

Reminder: Order frogs and earthworms for Chapter One.

How To Keep Animals

Ants

Ants can be kept for a few days in jars with an inch or so of soil in the bottom. A small piece of apple or a piece of wet paper towel should be put in with them. Punch holes in the jar cover, or cover with a piece of gauze. Keep them away from heat.

To keep ants for an indefinite time, a colony can be set up in soil that is confined between two sheets of glass. Such a setup can be purchased commercially or can be home-made. Provisions for feeding and supplying water to the insects must be made.

Earthworms

Earthworms need soil that is four or five inches deep and that is kept slightly damp. A large box or pan that is kept away from heat is needed. Stock the soil with worms that are healthy. Remove any dead or damaged worms. Cover the surface of the soil with a damp piece of burlap or four layers of wet paper toweling. Small amounts of hard-boiled egg yolk can be added to the soil every week or two to supply food.

Frogs

When frogs are delivered to school, put them in separate battery (or other large) jars in about 1½ inches of water. Keep them out of the direct sunlight and away from heat. Change the water daily. Of course, if your school owns a frog tank with continuously running water, this is ideal. Be sure to remove any frogs that die.

To keep frogs for any length of time, place in jars that are put in a refrigerator.

To keep frogs in the classroom, set up a bog terrarium in a tank with water on one side and soil (mud) on the other. A rock or two, a small log, and some moss will make it more attractive and will give the frogs a place to hide. The frogs should be fed once a week by offering them live food such as worms, insects or mealworms. Frogs respond to the movement, not the presence of food and will eat hamburger, liver, or other meat if it is dangled on a thread about three inches in front of them. If you look at page 29 (softback text) you will see some dramatic pictures of a frog seizing a winged insect in flight.

Planaria

Keep planaria in a glass or enamel pan that contains aged tapwater or pond water. Cover loosely and place in a dark spot. Feed them small pieces of raw liver or hard-boiled egg yolk about once a week. After feeding, the water should be changed. The planaria can be removed from the water by using a camel's hair brush. While they are regenerating, they should not be fed.

Microorganisms

Microorganisms of various types can be collected by taking water from a lake, pond, or stream and putting it in a jar with a few dead leaves and a bit of soil from the edge of the pond. Keep it lightly covered and out of the light for a few days. Check before using. Duckweed or algae often have microorganisms attached to them.

To make a hay infusion for culturing microorganisms, boil about 10 grams of hay in 1 liter of spring water or aged tapwater for about 30 minutes. Add two crushed grains of cooked wheat or rice. After a day or two, inoculate with microorganisms from another culture. Be sure to use clean glassware and to keep the culture at 70°F.

Interesting microorganisms are often cultured by simply letting two or three outer leaves of lettuce decay in some aged tapwater.

How To Prepare Solutions

Agar, nutrient

3 g	beef extract
5 g	peptone
15 g	agar
1000 ml	distilled water

Heat (do not boil) water with agar until it has dissolved. Add peptone and beef extract. Put into individual test tubes just enough of this mixture to cover the bottom of a petri dish. Plug with cotton. Sterilize in an autoclave or pressure cooker for 15 minutes at 15 pounds pressure. While the mixture is still hot, pour it into sterile petri dishes. Let the agar set, then turn the dishes upside down to cool.

Note: It is possible to buy nutrient agar in a powdered form from Difco Laboratories. It is listed as Bacto-Nutrient Agar. All you add is the water.

Biuret reagent

Combine 25 ml of 3% solution of copper sulfate and 1000 ml of 10% solution of potassium hydroxide.

Iodine Solution (Lugol's)

10 g	potassium iodide
100 ml	distilled water
5 ml	iodine crystals

Dissolve potassium iodide in the distilled water and add the iodine crystals.

Methylene blue

Dissolve 1.48 g methylene blue dye in 100 ml 95% ethyl alcohol.

Classroom Supply List

The list contains all the items necessary to do all the Explorations. Approximate quantities are for a class of 25. All the items are readily available from a number of scientific supply houses or local stores. Each item is keyed to the amount needed and chapter where used.

Classroom Supply List

Expendable Materials	**Amount**	**Chapter**
ABO blood typing serum	1 set	7
acetone	1 pt	3
agar, nutrient	1 lb	15
alcohol, ethyl	1 pt	3, 7, 9
apple	1	6
ammonia, household	1 pt	6
bacteria, nonpathogenic	1 culture	15
Bacto-disks (antibiotic disks)	1 package	15
bags, plastic, 1 qt size	25	12
large size	10	12
Benedict's solution	1 qt	6
Biuret solution	1 pt	6
bloodstain (Wright's)	1 bottle	7
blotter, 3 in x 6 in	10	3
1 in x 5 in	5	3
desk size	2	3
bones, chicken wing or leg	10	1
bread	3 slices	1, 6, 12
carrots (1 bunch, optional)	5	6
chalk	1 box	3, 4, 13
chromatography paper (Whatsman's #1)	1 package	3
clay, modeling	10 lb	14
cloth, black, 8 in x 11 in	6	1
cork	3	5
corn starch	1 lb	6
cotton, absorbent	3 lb	3, 7, 8, 9
dialysis tubing, 1 in or 1½ in	1 roll	6
eggs, hardboiled	2	6
unincubated chicken	6	12
2 day old fertilized chicken	6	12
4 day old fertilized chicken	6	12
5 day old fertilized chicken	6	12
envelopes	25	2, 4, 13
ether, ethyl	1 lb	3, 11
eyes of steer, lamb, pig (optional)	10	10
flowers (gladiolus, tulip, etc.)	12	12
food, sugar	10 g	1
bread crumbs	10 g	1
bacon fat	1 slice	1
food coloring, assorted	1 box	3
foods, assorted baby	12 jars	6
frog skin (shed in water by living frog)	1	5
glucose	1 lb	6
hearts, fresh (cow, lamb, or pig)	6	7
ink or food color, red	1 pt	6
iodine	10 g	5, 6
kidneys, lamb or pig	10	9
Kool-Aid	12 packages	6
lancets, blood (sterile and disposable)	1 package	7
leaves, autumn	several	3
leaves, green	2	3
lentils	1 package	3
Life Savers, assorted flavors	15 packages	10
liver, fresh	¼ lb	6
lung-heart-trachea combination, fresh (optional)	1	7, 8
matches, wooden	1 package	11
materials, assorted kinds	several	5

(human hair, feathers, thread, tissue, silk, wool, butterfly wing, parts of insects, etc.)		
methylene blue or Lugol's iodine	10 g	5, 6
newsprint	1 page	5
mushrooms, fresh	10	12
nylon stocking	1	5
oil, cooking	1 pt	6
onion, raw	1	5
paper, brown, 12 in x 12 in	several sheets	6
construction, assorted colors	several packages	13
lens	12 books	5
paper towels	6 rolls or packages	3, 11, 12
paraffin	1 lb	6
pencils, red, green, blue	25	1, 4, 6, 7, 8, 9
lead with erasers	12	1
glass marking (wax pencils)	3 boxes	1, 3, 6
plant markers, wooden	100	12
pond water	2, 3 qts	5, 6
potatoes, sweet	10	12
white	5	12
PTC paper	1 package	13
raisins or prunes	1 package	6
rubber bands	1 box	3
seeds, bean	1 package	3
corn	1 package	3
lentil	1 package	3
pea	1 package	3
radish	1 package	3
syrup, molasses or pancake	1 pt	6
tape, cellophane	10 rolls	4, 13, 14
thumbtacks	1 box	3
tomato, fresh	1	5
toothpicks	1 box	3, 5, 7
vermiculite or sand	15-20 lb	12
vinegar, distilled	1 bottle	1
yeast, dry	1 package	12

Charts	**Amount**	**Chapter**
bird chart	1	1
fossil chart	1	14
frog chart	1	11
kidney chart	1	9
human body chart or model	1	6, 7, 8, 9, 10, 12
model of breathing system (bell jar)	1	8
model or chart of skin (optional)	1	9

Glassware	**Amount**	**Chapter**
beakers, 400 ml	6	3, 6, 8
bottles, small ink, with tops	5	6
cover slips, microscope (plastic, thickness No. 2)	3 boxes	5, 7
dishes, petri	72	7, 8, 12, 15
funnels, small	10	6
glass or plastic, transparent	5	2
sheets, 8 in x 11 in or larger		
6 in x 11 or smaller	20	3
jar, bell	1	8
jars or beakers, glass, 500 ml	12	6
jars, covered (or dishes)	12	1
battery, 8 in x 6 in	12	1

jug, 1-gal, wide mouth	1	8
pipettes (medicine droppers)	6 packages	5, 6, 11, 12
slides, microscope, 3 in x 1 in	2 boxes	5, 7, 8
test tubes	180	3, 6
air tight tops	36	3
tubing, glass, 12 in-15 in (optional)	5 pieces	6, 8

Hardware	**Amount**	**Chapter**
borers, cork (optional)	5	6
bunsen burners	12	3, 6
forceps	12	1, 5, 6, 11
hammers, small	5	1
knife, large kitchen, 10 in	1	7, 8, 9
lamps, high intensity (or flashlights)	6	1, 2
lens, hand	25	1, 5, 12, 15
mesh wire tops for battery jars	12	1
microscopes	25	5, 7, 15
mirrors (approximately 3 in x 4 in)	10	6
needles, dissecting	12	10, 11
pins	1 package	11
potato peelers	5	6
racks, test tube	12	3, 6
ring stands, with clamps	5	3, 6
scalpels	12	8, 9, 10, 11, 12
scissors	36	2, 3, 4, 5, 8, 10, 11, 12, 13, 14
stapler	1	10
stethoscope (optional)	2	7
stoppers, cork or rubber, one hole	5	6
two holes	1	8
tongs, utility, 9 in	6	6
tubing, rubber, 2-ft lengths	several pieces	8
tuning forks	5	1, 10

Living Materials	**Amount**	**Chapter**
bird, living (optional)	1	1
earthworms, large	36	1
earthworms or mealworms (food for frogs)	25	1
Elodea	3 bunches	3, 5, 6
frogs, living	24	1
preserved	10	11
goldfish or guppies	12	6, 7
hydra	25	6
insects, ants	25 per group	1
leaves, African violet, begonia or Bryophyllum	several per group	12
planaria	50	6, 12
plants, various kinds (geranium, coleus, etc.)	10	3, 12
one-celled (from pond or fish tank)	2 pt	6
sensitive, or Venus's flytrap	5	3
protozoa, living	1 culture	6
snails, large, fresh water	24	3
worms, tubifex	100	6

Measuring Devices	**Amount**	**Chapter**
balance, pan, and weights	1	6
meter sticks, 30 cm	12	3, 10, 13
stopwatch	6	1, 2, 7, 8, 10
thermometers, Celsius, Fahrenheit	10 (5 of each)	6, 9

Miscellaneous Materials	Amount	Chapter
bird specimens, stuffed (optional)	assortment	1
birds' nests and eggs	assortment	1
boards, wooden bread, 15 in x 8 in	2	1
brushes, artist's	6	1
test tube	12	3, 6
clothespins, clip	1 package	8
corks (to fit large test tubes)	12	3
cups, heavy paper (hot cup or cottage cheese containers to fit over flower pot)	10	3
feathers, contour	60	1
downy	60	1
quill	60	1
flowerpots, small	60	3, 12
fossils	assortment	14
globe, world (optional)	1	4
labels	6 boxes	1, 3, 11, 15
pans, enamel, 12 in x 8 in x 4 in	12	1, 10
dissecting	12	7, 8, 11
3-quart	2	1, 3
Password game (optional)	1	2
petroleum jelly	1 jar	8
skeleton, bird (optional)	1	1
slides, animal tissues	assortment	5
human blood	3	5, 7
spoons, plastic	12	6

Suggested Teaching Schedules

The following schedules are based on a 180-day year with biology being studied for approximately 50 minutes per day. Schedule 1 indicates the number of days required to complete the starred Explorations or Readings. They represent the core of the program and are marked in the Table of Contents (pages T73–T76).

Schedule II includes the days needed to complete all of the Explorations. There is no provision in the schedule for the Readings. Use the Readings as a springboard to start the Explorations. We stress that it is unwise to plan to complete all the activities in one school year.

		Schedule I		Schedule II
Chapter		*Days*		*Days*
1		11		14
2		7		10
3		12		15
4		7		13
5		11		17
6		14		21
7		6		8
8		7		7
9		4		6
10		6		6
11		3		3
12		13		21
13		4		7
14		5		5
15		3		7
16		3		5
	Total	116	Total	165

General Bibliography

Colbert, E. H. *Dinosaurs.* Man and Nature Publications Science Guide No. 70. Ninth Edition. New York: The American Museum of Natural History, 1960.

Hainsworth, Marguerite D. *Experiments in Animal Behavior.* Boston: Houghton Mifflin Co., 1968.

Kimball, J. W. *Biology.* Reading, Mass.: Addison-Wesley Publishing Co., 1974.

Klinckmann, E. *Biology Teachers' Handbook.* BSCS. 2nd ed. New York: John Wiley and Sons Inc., 1970.

Lerner, Michael I. *Heredity, Evolution, and Society.* San Francisco: Freeman, 1968.

Oxenhorn, Joseph M. *Teaching Science to Underachievers in Secondary Schools.* New York: Globe Book Co., 1972.

Simpson, G. G. and W. S. Beck. *Life—An Introduction to Biology.* 2nd ed. New York: Harcourt Brace Jovanovich, 1965.

Classroom Library

Cain, Arthur H. *Young People and Smoking.* New York: The John Day Co. Inc., 1965.

Clymer, Eleanor. *The Case of the Missing Link.* New York: Basic Books, Inc., 1962.

Cooper, George Allen. *Charles Darwin: Voyager-Naturalist.* New York: Macmillan Co., 1966.

Hardwick, Richard. *Charles Richard Drew.* New York: Charles Scribner's Sons, 1973.

Hess, Lilo. *Animals that Hide, Imitate and Bluff.* New York: Charles Scribner's Sons, 1970.

Mann, John Harvey. *Louis Pasteur, The Germ Killer.* New York: The Macmillan Co., 1966.

Marcus, Rebecca B. *William Harvey, Trailblazer of Scientific Medicine.* New York: Franklin Watts, Inc., 1963.

Rosenberg, Nancy and Reuven K. Snyderman, M.D. *New Parts for People: The Story of Medical Transplants.* New York: W.W. Norton and Company, Inc., 1969.

Rubin, Elizabeth. *The Curies and Radium.* New York: Franklin Watts, Inc., 1961.

Scheinfeld, Amram. *Why You Are You: The Story of Heredity and Environment.* Associated Press, 1971.

Schneider, Leo. *Lifeline: The Story of Your Circulatory System.* New York: Harcourt Brace Jovanovich, 1958.

Suggested Audiovisual Aids

Most school systems have their own centers from which visual aids can be ordered. Films, film loops, filmstrips should be previewed by the teacher before presenting them to the class. Do not order from a catalogue description alone.

State libraries and museums as well as local libraries and museums are often equipped to lend audiovisual aids to schools. Free films are also available from other sources, some of which are listed below.

Aetna Life and Casualty Co.
Film Library
151 Farmington Ave.
Hartford, CT 06115

Bell System Telephone Co.
Your Local Business Office

Eastman Kodak
Audio Visual Service
343 State St.
Rochester, NY 14650

Fish and Wildlife Service
Bureau of Commercial Fisheries
Audio-Visual Services
1815 No. Ft. Myer Drive
Arlington, VA 22209

Shell Film Library
450 No. Meridian St.
Indianapolis, Ind. 46204

U.S. Atomic Energy Commission
Division of Public Information
Washington, DC

General Objectives of the Program

The primary goals of this text are to help students

1. develop and maintain a high degree of motivation with regard to both science and the learning process.
2. master fundamental learning skills, particularly the important scientific skills of observing, describing, quantifying, organizing data, predicting, testing, and generalization.
3. relate science concepts to the students' immediate concerns, interests and experience.
4. develop a more positive self image and a higher degree of confidence in themselves and in their ability to handle schoolwork.
5. identify and appreciate their individual abilities and aptitudes, and the interests of others.
6. be aware of themselves as organisms in a community of organisms sharing a closed ecosystem.
7. develop a sensitivity to the environment and an appreciation of life in all its forms.

General Behavioral Objectives

After completing this program, the students will demonstrate mastery of the objectives by being able to

1. organize and evaluate laboratory data effectively.
2. use appropriate problem solving techniques.
3. work cooperatively in groups.
4. communicate through oral and written expression.
5. handle equipment, materials, and organisms in a laboratory setting.
6. observe and record data.
7. interpret data and draw conclusions.
8. plan and carry out tests of hypotheses.
9. use appropriate controls in laboratory tests.

II. STUDENT SCORECARD (WORK HABITS)

Key

- ■ Yes
- ☐ No
- ▨ Unobserved

Names

Work Habits																						

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I. STUDENT SCORECARD (BEHAVIORAL OBJECTIVES)

Key ■ Mastery ◩ Partial Mastery ☐ Incomplete Objectives		Names																				
Chapter ______ Exploration ______																						
Chapter ______ Exploration ______																						
Chapter ______ Exploration ______																						
Chapter ______ Exploration ______																						

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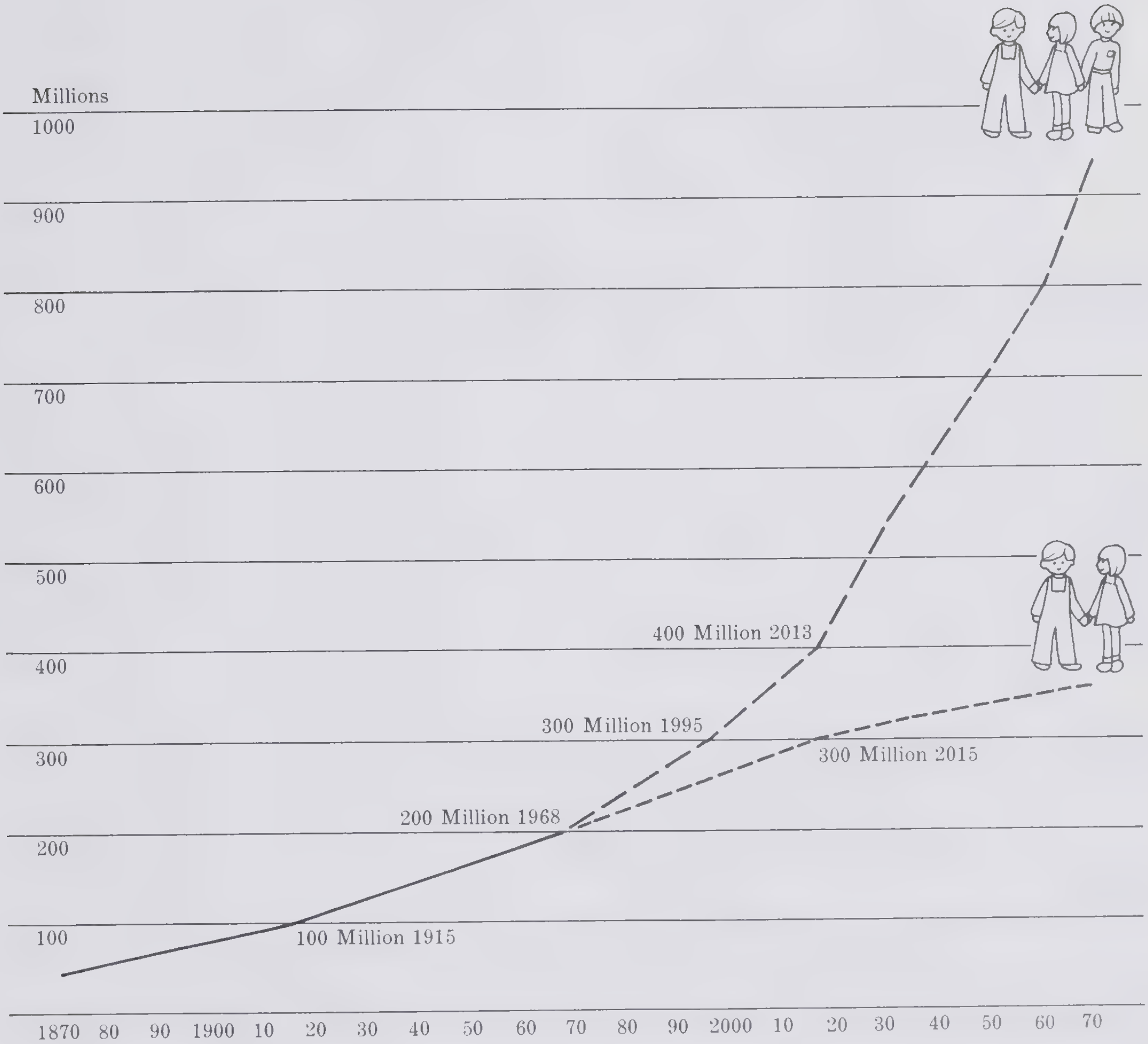
Using Graphs

The following graphs may be duplicated and distributed to the students as a supplement to the course. They show different ways that information can be organized pictorially and graphically. The topics are varied and might interest the class enough to start a discussion. Let the students analyze each graph but don't expect them to memorize any of it.

U.S. Population: 2 vs. 3-Child Family



The population of the United States passed the 100-million mark in 1915 and reached 200 million in 1968. If families average two children in the future, growth rates will slow, and the population will reach 300 million in the year 2015. At the 3-child rate, the population would reach 300 million in this century and 400 million in the year 2013. (Projections assume small future reductions in mortality, and assume future immigration at present levels.)

Sources: Prior to 1900—U.S. Bureau of the Census, Historical Statistics of the United States, Colonial Times to 1957, *1961. 1900 to 2020—U.S. Bureau of the Census* Current Population Reports, *Series P-25. 2021 to 2050—unpublished Census Bureau projections. Beyond 2050—extrapolation.*

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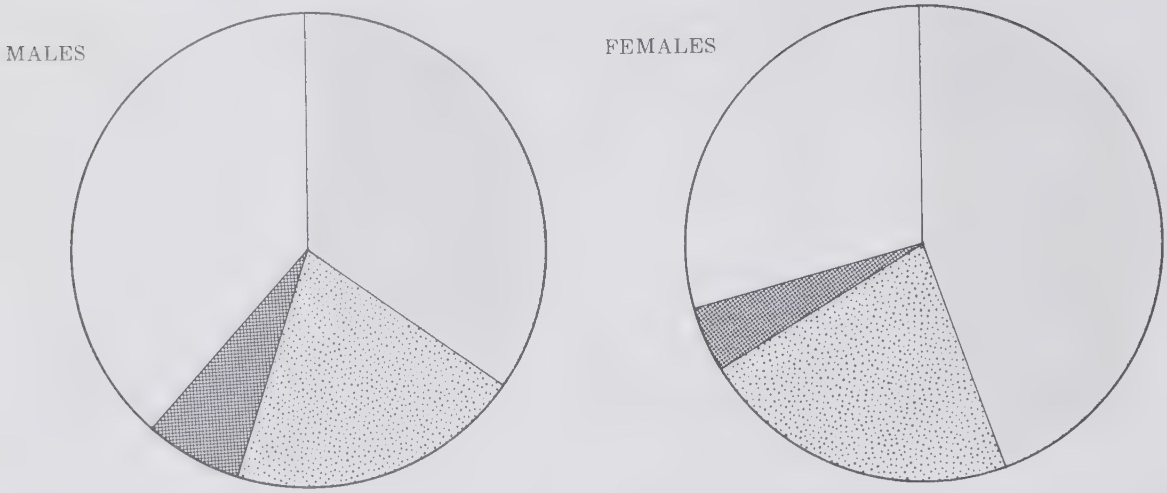
Participation in Outdoor Recreation, By Sex: 1970
(*Source:* Department of Interior, Bureau of Outdoor Recreation,
The 1970 Survey of Outdoor Recreation Activities, Preliminary Report, 1972.)



KEY OUTDOOR ACTIVITIES
☐ *Social Activities:* Walking, picnicking, nature walks, wildlife photography, bird watching.
▨ *Backwoods Activities:* Camping, hunting.
░ *Water Activities:* Swimming, boating.
☐ *Active Sports:* Outdoor sports, bicycling, horseback riding.

PICTURE GRAPH
Average Heartbeat Rates for Different Animals.
♥ equals 10 heartbeats per minute.

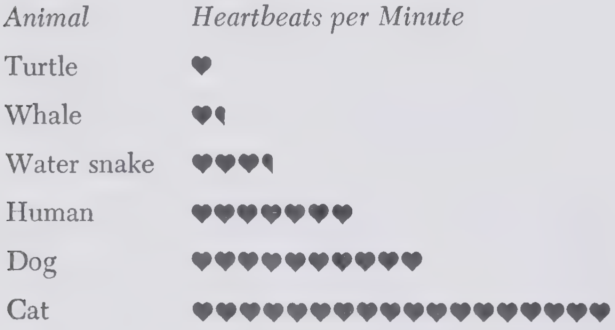


TABLE
Average Heartbeat Rates for Different Animals.

Animal	*Heartbeats per Minute*
Turtle	10
Whale	15
Water snake	35
Human	70
Dog	100
Cat	180

Source: Educational Research Council of America.

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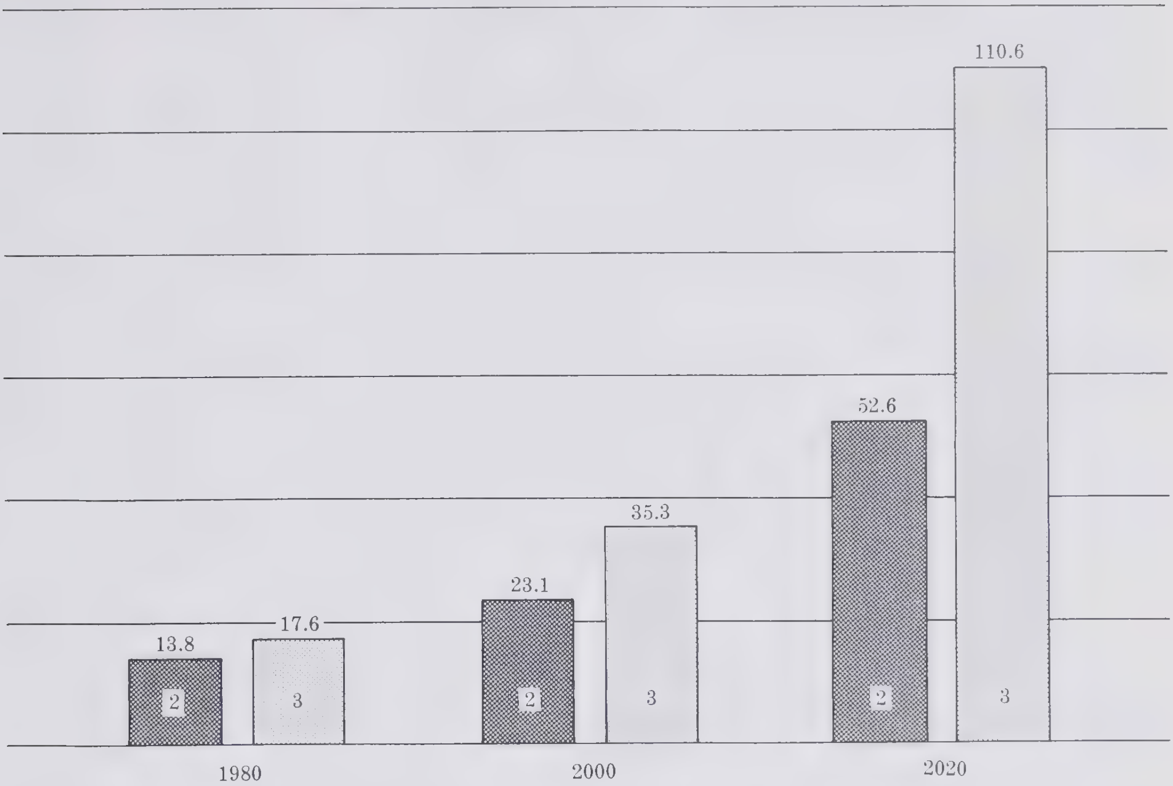
Regional Water Deficits: Billions of Gallons Per Day



Despite an abundance of water nationally, rapid population growth will cause the extent and severity of regional water deficits to spread more rapidly than they would with slower population growth. This is the case even assuming maximum development of water storage facilities and tertiary treatment of waste water.
Chart shows projected effects of growth at 2-child and 3-child rates.

Estimates assume rapid economic growth.

Source: Derived from Ronald G. Ridker, "Future Water Needs and Supplies, with a Note on Land Use" (prepared for the Commission, 1972).

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Hard Cover Text Users
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The following pages contain materials such as *Use Your Wits!* and illustrations that will need to be reproduced for students who have hard cover texts. Permission is hereby granted by the publisher to reproduce the materials on pages T25-T70 in quantities for classroom use.

Chapter 1 Use Your Wits!

This game is played like *Jeopardy*. You might have seen it on television.

The Answer Box below gives you answers, and you have to think of questions to match them. In this game the answers are divided into five groups, Insect, Earthworm, Frog, Bird, and General. Be sure that the questions you write fit the right group.

Each question is worth 10, 20, 30, 40, or 50 points.

ANSWER BOX

Points	Insect	Earthworm	Frog	Bird	General
10	*six*	*tunnel in the ground*	*tadpole*	*feathers*	*stimulus*
20	*light*	*dampness*	*hundreds*	*migration*	*response*
30	*cover garbage cans*	*through its skin*	*in the mud*	*by the stars*	*environment*
40	*social*	*fertilize the soil*	*color of the skin*	*light and strong*	*vertebrate*
50	*lays eggs in water*	*bristles*	*breathe slower*	*warm-blooded*	*control*

Follow the examples on the Question Box. Write as many questions as you can. Then add up the number of points you earned. You might want to compare your questions with the ones written by the rest of the class. Do you think there will be only one right question for each answer?

QUESTION BOX

Points	Group	Answer	Question that matches the answer
10	*Frog*	*Tadpole*	*What is a baby frog called?*

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Points	Group	Answer	Question that matches the answer

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Chapter 2 Use Your Wits!

Part One

TRIAL AND ERROR · PROBLEM SOLVING · INBORN · HABIT · CONDITIONING

What kind of human behavior is each of the following activities? Choose your answer from the five words above. Put one letter of your answer in each square of the puzzle. Number 5 has been filled in as an example.

1. Having good table manners
2. Sneezing
3. Deciding whether to take a typing course
4. Blinking in a bright light
5. Deciding whether or not to smoke
6. Learning a new dance step
7. Doing a math problem
8. Being on time for school every day
9. Learning to tie your shoes
10. Pavlov's experiments with dogs
11. Deciding what color to paint your room

1	○													
2				○										
3							○							
4				○										
5	P	R	O	B	L	E	M	Ⓢ	O	L	V	I	N	G
6				○										
7	○													
8				○										
9									○					
10			○											
11								○						

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When you have finished, write the letters that are in the circles in

each row. ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___

What does this mean? ______________________________

Part Two

When a person drives a car, he uses many kinds of behavior. Try to choose the best word in column B to match each term in column A.

COLUMN A

1. Choosing a car ____
2. Stop at a red light ____
3. Pull over to the curb at the sound of a siren ____
4. Pupil of the eye opens for driving in the dark ____
5. Step on the gas to make the car go faster ____
6. Learn how to park next to a curb ____
7. Follow a map to get to another city ____
8. Turn on a signal blinker light just before you go around a corner ____

COLUMN B

a. Inborn behavior
b. Habit
c. Trial and Error
d. Problem Solving

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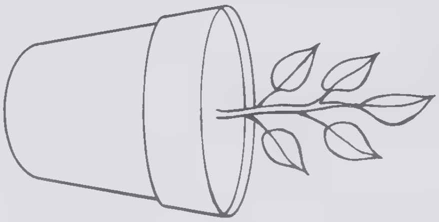
Chapter 3 Use Your Wits!

Below are 13 pairs of pictures. Think about how the plant or seed responds in each case. Then finish the incomplete picture in each pair.

You may want to score yourself. ______________________

5-6 right — Fair
7-9 right — Good
10-13 right — Excellent

1



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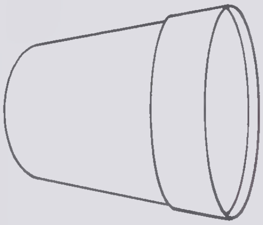

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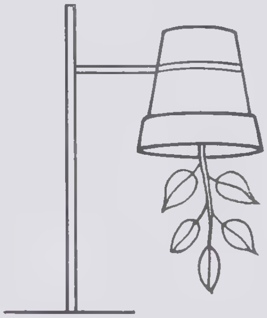

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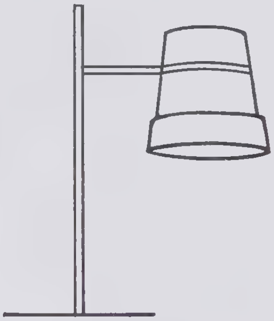

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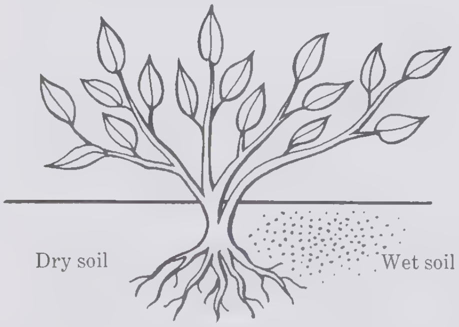

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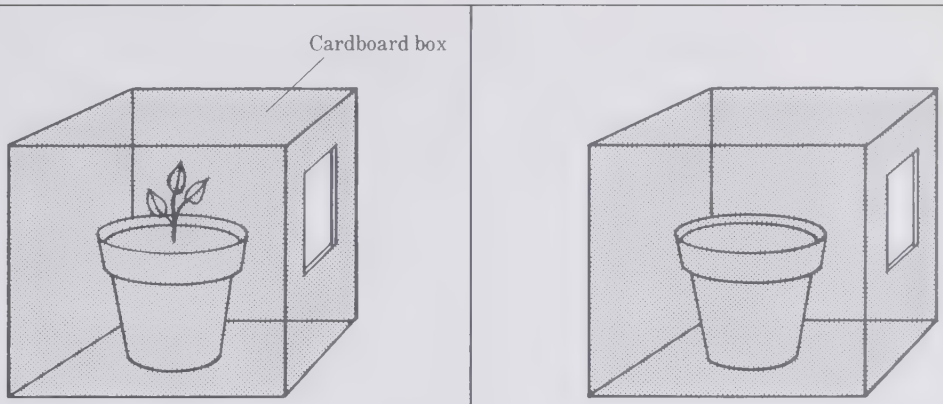

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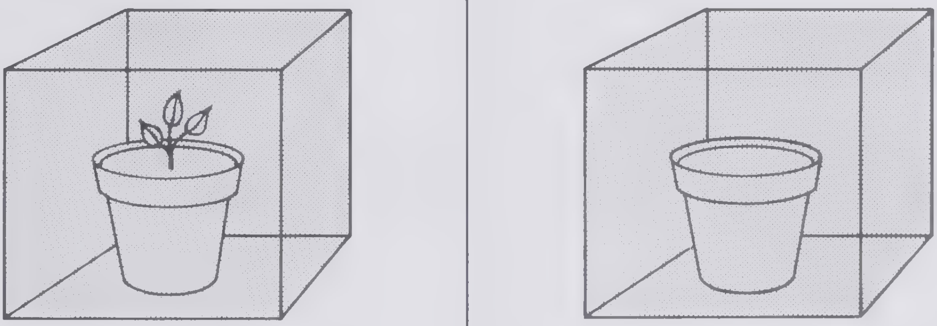

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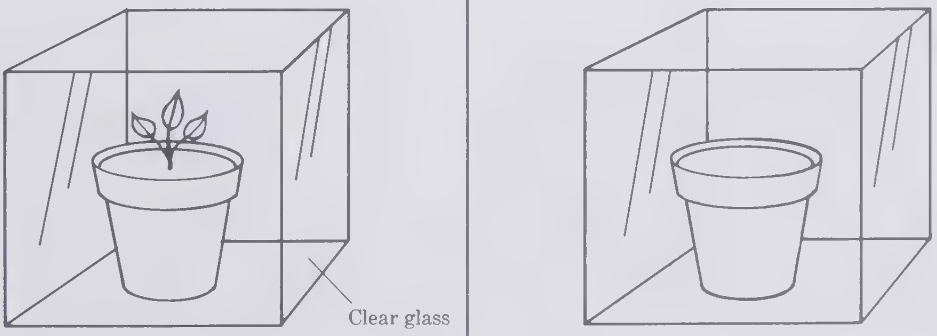

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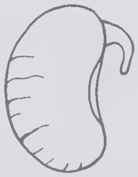

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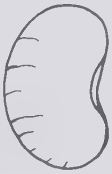

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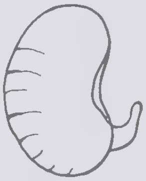

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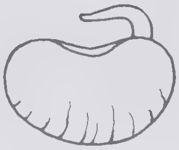

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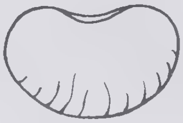

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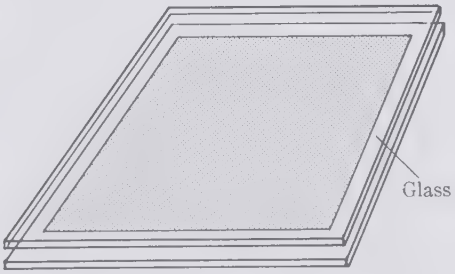

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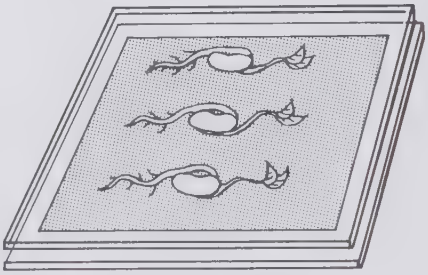

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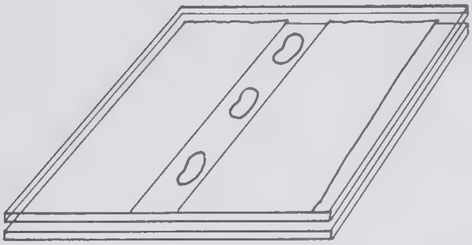

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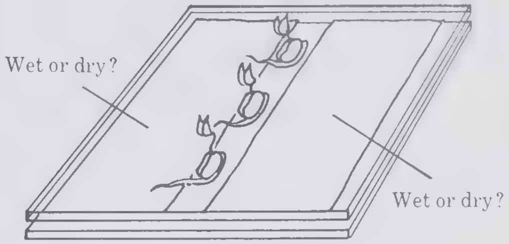
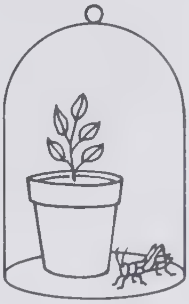

Wet or dry?
Wet or dry?

After

12



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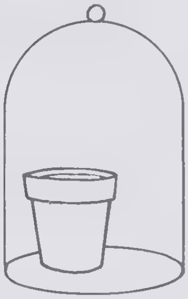

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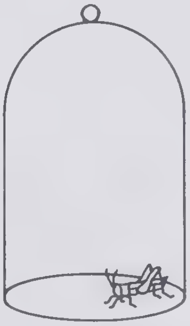

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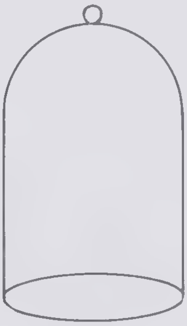

After

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Chapter 4 Use Your Wits!

Part One

The answer to each question is hidden in the mixed-up letters. Put the letters in the right order and write the answer in the blank spaces. Give yourself ten points for each correct answer.

1. Since plants are the only living things that can produce food, they are called ___ ___ ___ ___ ___ ___ ___ ___ ___. (soderpruc)
2. The energy that plants use to make food comes from the ___ ___ ___. (nus)
3. Plants make food from materials in the ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___. (niverntomen)
4. Bacteria are important in a food web because they are ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___. (serdeosmocp)
5. The chief problem of living in a desert is the lack of ___ ___ ___ ___ ___. (retaw)
6. The biggest problem in staying alive in the tundra is the ___ ___ ___ ___. (dolc)
7. A deciduous forest has weather that ___ ___ ___ ___ ___ ___ ___ (genachs) from season to season.
8. If the ocean is polluted, the ___ ___ ___ ___ ___ (ragle) fish may be more dangerous to eat than the others.
9. A group of one kind of living things is called a ___ ___ ___ ___ ___ ___ ___ ___ ___ ___. (toiolunapp)
10. Living in a big city has some disadvantages and some ___ ___ ___ ___ ___ ___ ___ ___ ___ ___. (vantdagaes)

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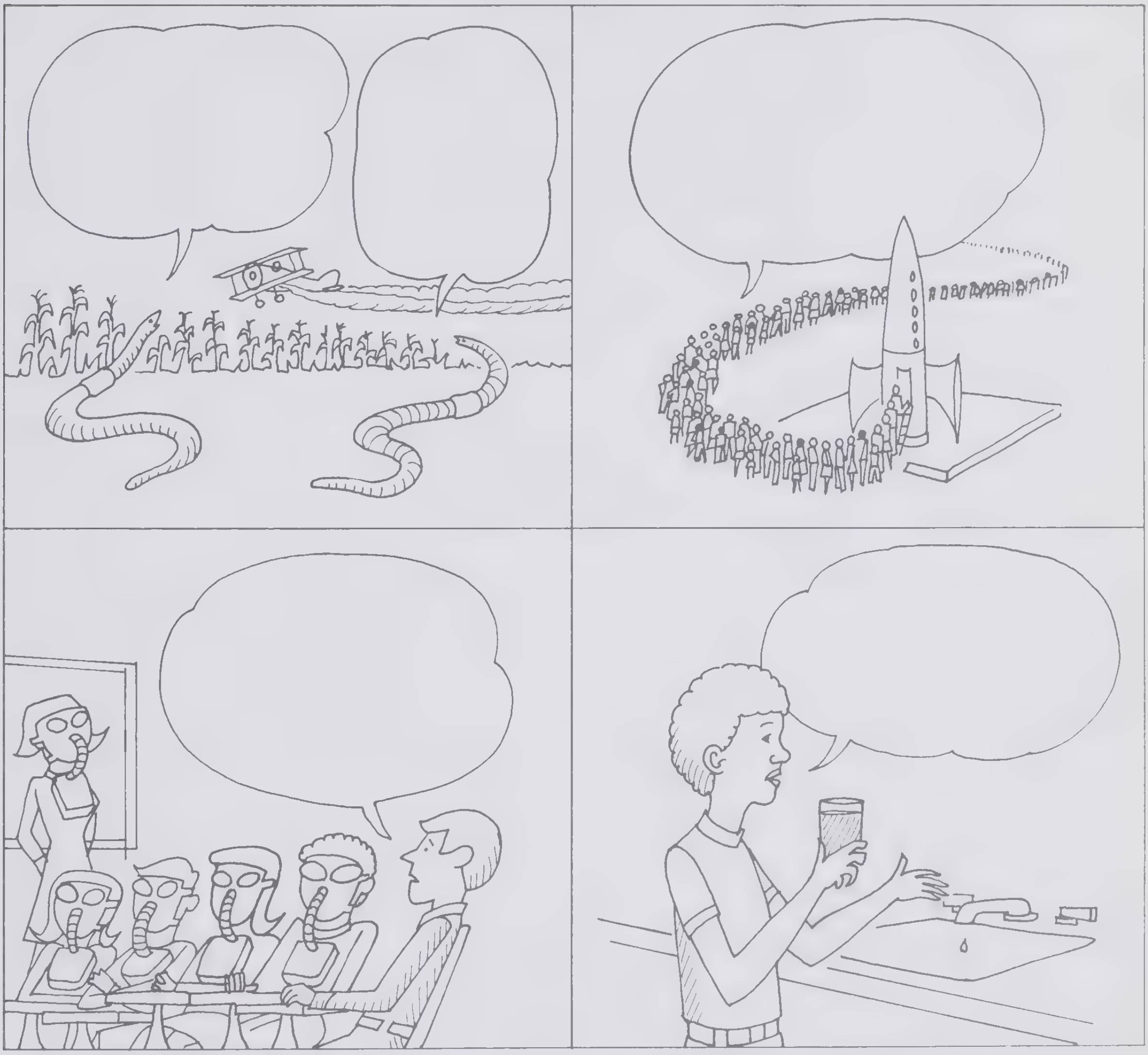
Part Two

Use your wits to complete these cartoons. What do you think about the environmental mess?



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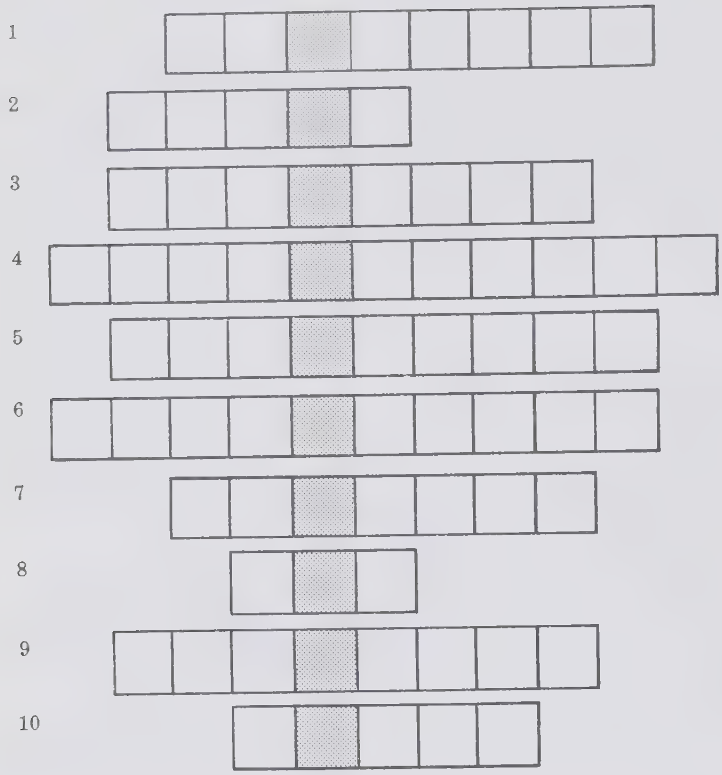
Chapter 5 Use Your Wits!



Fill in the rows of this puzzle by using the clues below.

1. The outside layer of an animal cell.
2. You can often see cells better on a slide if you __________ them.
3. A microscope that magnifies thousands of times.
4. Green part in a plant cell.
5. Cells are filled with this thin jelly.
6. To get a focus with low power, you turn the coarse __ _______ ___ toward you.
7. The control center of a cell.
8. The __________ power objective of a microscope is used first.
9. The part of a compound microscope you look through.
10. What Robert Hooke called the structures that cork is made of.

The letters in the colored squares form the name of an important tool of the biologist. Write the word here.

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Chapter 6 Use Your Wits!

HERE is a number code. Each number stands for a different letter. Use this code to find out what the secret words in column 1 are. Write each letter over the number in the code word. Then, draw a line between each word in column 1 and the term in column 2 that matches it best.

CODE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Z	Y	X	W	V	U	T	S	R	Q	P	O	N	M	L	K	J
18	19	20	21	22	23	24	25	26								
I	H	G	F	E	D	C	B	A								

COLUMN 1	COLUMN 2
18-12-23-18-13-22	sunshine vitamin
20-15-6-24-12-8-22	does the work of digestion
5-18-7-26-14-18-13 23	where the digested food is needed
23-18-21-21-6-8-18-12-13	test for starch
22-13-1-2-14-22-8	the body sugar
11-9-12-7-22-18-13-8	it is 6 meters long
18-9-12-13	needed to make red blood
23-18-20-22-8-7-18-12-13	the mixing of molecules
15-18-5-22-9	largest digestive gland
8-14-26-15-15 18-13-7-22-8-7-18-13-22	meat, fish, eggs have a lot
24-22-15-15-8	a measure of food energy
24-26-15-12-9-18-22	gets food ready for cells to use

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Chapter 7 Use Your Wits!

There are words hidden in the puzzle. All the words have to do with circulation. Some words are going across and some are going down in the puzzle. Find as many as you can and draw lines around them.

H	C	A	R	T	E	R	Y	A	W
E	A	V	E	I	N	B	R	H	H
M	P	E	D	V	A	L	V	E	I
O	I	N	C	F	O	O	E	Z	T
G	L	T	E	G	R	O	S	P	E
L	L	R	L	K	T	D	S	U	C
O	A	I	L	N	A	T	E	L	E
B	R	C	R	S	C	Y	L	S	L
I	Y	L	O	R	T	P	B	E	L
N	B	E	O	O	D	E	Y	B	S

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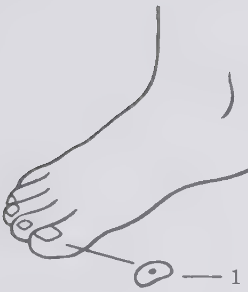
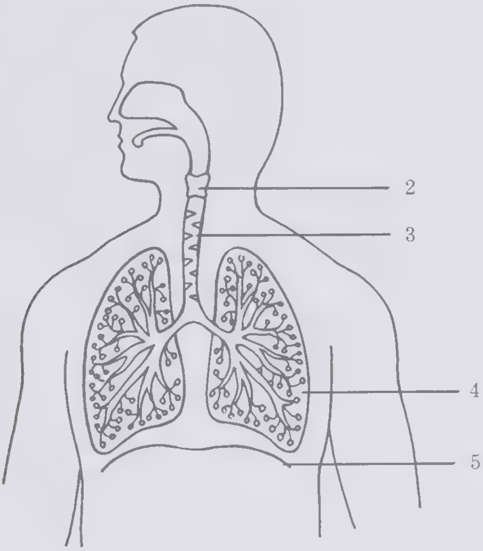
Chapter 8 Use Your Wits!



Here is a cell in your big toe that needs oxygen. It must also get rid of carbon dioxide, which is waste.

Here are the parts of the body that take oxygen into the body. They also send the carbon dioxide out of the body. Match the numbers from the diagrams with each item below. You can use a number more than once.



______ a. the muscle that forces air in and out of the lungs

______ b. the lungs

______ c. the windpipe

______ d. where the blood picks up oxygen

______ e. where the blood picks up carbon dioxide

______ f. the diaphragm

______ g. where most of the capillaries that take in oxygen are

______ h. where the voice box is

______ i. where the air sacs are

______ j. where the oxygen is used.

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Chapter 9 Use Your Wits!

THIS GAME is played like *Jeopardy* on TV. The answer box gives you the answers. You have to think of the questions.

ANSWER BOX

Points	Kidney	Skin	General
10	*two*	*dead cells*	*98.6°F*
20	*urine*	*acne*	*carbon dioxide*
30	*body cells*	*pigment*	*fingerprints*
40	*artery*	*sweat*	*evaporation*
50	*ureter*	*albino*	*Celsius thermometer*

Write as many questions as you can in the Question Box. Then add up the number of points you have earned.

QUESTION BOX

Points	Group	Answer	Question that matches the answer
20	*General*	*Carbon dioxide*	*What is the waste that is taken out of the blood by the lungs?*

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Chapter 10 Use Your Wits!

This is a game of *Concentration.*

Make copies of the following page. Then cut the page down the middle. Have students color in the back side of each sheet showing the parts of the brain. After this, tell the students to cut the sheet into cards.

Put the cards face down on your desk. Put the white cards in two rows on the left and the colored cards in two rows on the right. Turn a white card and a colored card over. If the two match, pick them up and keep them. Then try for another match. If the cards don't match, put them face down in the same place and let your partner try.

Suppose you think a pair of cards matches, but your partner does not. Look up the right answer. If your partner was right, he or she gets an extra turn.

At the end of the game, the person that holds the most cards is the winner.

It might be fun to make one big game by using two or more sets of cards.

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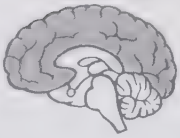
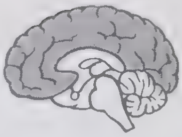
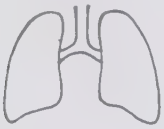
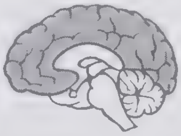
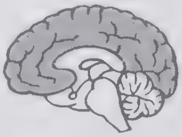
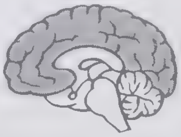
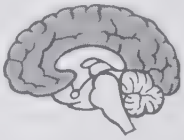
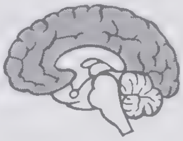
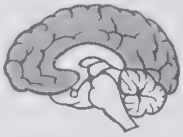
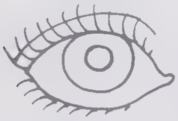
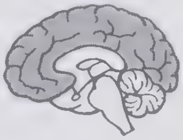
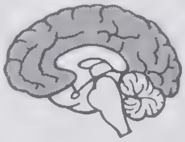
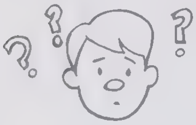
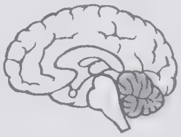
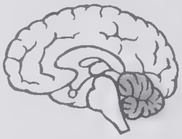
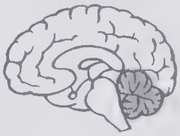
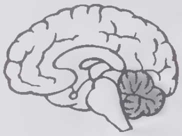
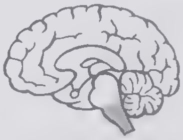
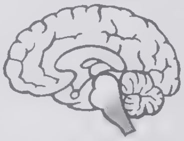
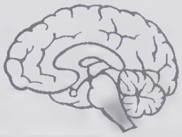
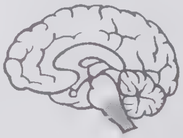
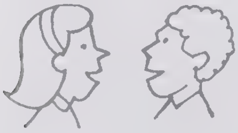
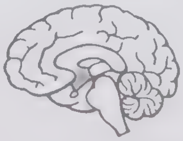
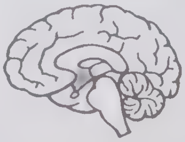
Hearing 	Touching 	Cerebrum 	Cerebrum 
Breathing 	Heartbeat 	Cerebrum 	Cerebrum 
Thinking 	Coughing 	Cerebrum 	Cerebrum 
Digesting 	Bike riding 	Cerebrum 	Cerebrum 
Seeing 	Being angry 	Cerebrum 	Cerebrum 
Memory 	Tasting 	Cerebellum 	Cerebellum 
Walking 	Balance 	Cerebellum 	Cerebellum 
Throwing a basketball 	Being frightened 	Medulla 	Medulla 
Smelling 	Solving a problem 	Medulla 	Medulla 
Talking 	Planning 	Hypothalamus 	Hypothalamus 

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Chapter 11 Use Your Wits!

Use what you learned this year to help you solve the puzzle on the next page. Use the clues below to fill in the puzzle.

Across

1. Cut open
2. Female frog lays hundreds of them
3. Inside
5. Parts of the body that pick up sound vibrations
7. Group of food chains
9. To live in water, the frog must be a good ____________.
10. The sex that has testes
11. The part of the male's body that makes sperms
13. The part of the body that stores red blood cells
14. A large dark red gland that has three parts
15. All living things get energy from the ____________.
16. A frog has ____________ lungs.
18. An organ that takes liquid waste out of blood

Down

1. The breaking down of food
3. Food goes from the stomach to the small ____________.
4. The frog has extra eye ____________.
6. They carry oxygen in the blood
7. A tool used in dissecting
8. Where urine is stored
10. These parts of the body move the bones
12. The outer body covering
14. Organs that take oxygen out of the air
17. The part of the female's body that makes and stores eggs

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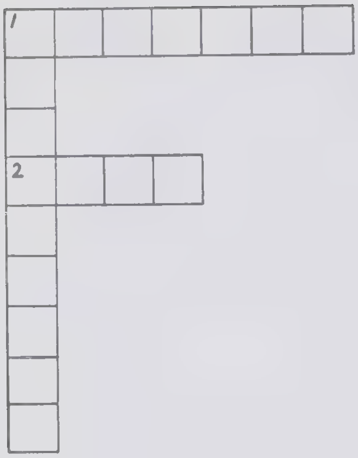

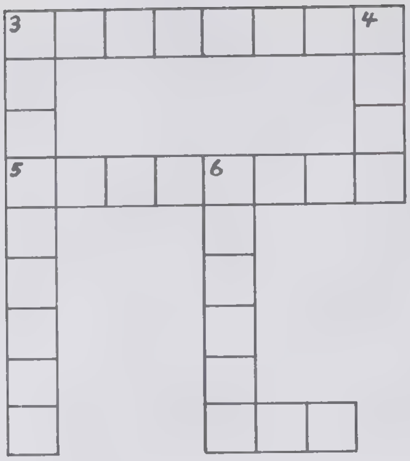

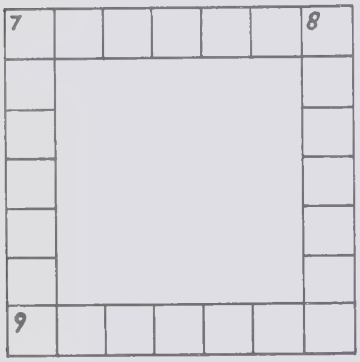

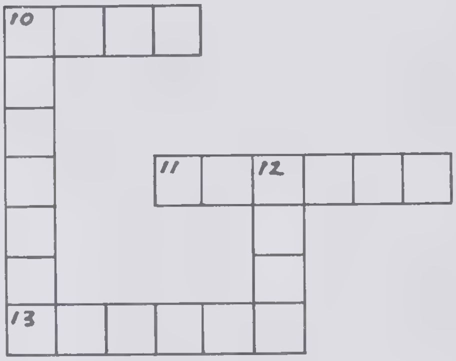

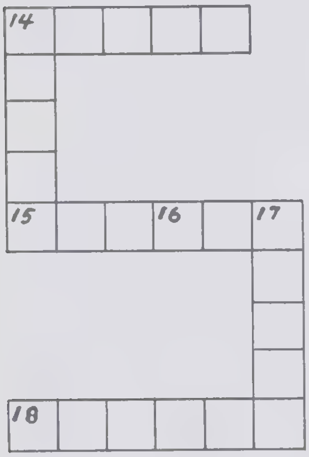

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Chapter 12 Use Your Wits!

Part One

1	~~F~~	~~L~~	~~O~~	D	~~W~~	~~E~~	~~R~~	N	S	P	E	R	M	A	S
2	E	G	C	G	S	A	R	P	R	I	O	E	R	E	S
3	H	O	E	R	V	A	E	R	D	I	T	Y	A	R	Y
4	C	H	A	R	A	C	T	E	R	I	S	T	I	C	S
5	A	F	S	E	X	U	R	A	L	O	B	E	E	M	S
6	S	W	I	M	O	N	M	I	N	G	W	A	E	R	M
7	P	G	E	E	T	N	E	A	R	L	A	T	I	O	N
8	F	E	R	T	T	I	O	L	I	Z	A	T	I	O	N
9	A	N	O	T	B	H	E	R	L	O	O	O	D	N	E
10	U	P	S	T	R	E	A	M	M	A	M	M	A	L	S

Answers to the questions are hidden in the puzzle. In each row cross out the letters of the words that answer each question. In some rows there are two answers.

For example, the first answer is FLOWER. So the letters in FLOWER have been crossed out.

Row 1 — Part of the plant that reproduces
1 — Male reproductive cells
2 — Female cell produced by the ovary
2 — Reproductive cell produced by mushrooms
3 — Female organ that forms eggs
5 — Insects that carry pollen
5 — Reproduction by one parent
6 — Sperms move this way
6 — Eggs are put in incubation to keep them ____________
7 — Colorful part of a flower
8 — Process of a sperm uniting with an egg
9 — Carries food from egg yolk to the developing chick
10 — Where the salmon goes to reproduce
10 — Animals that carry young inside the body, for example — YOU

The letters that were *not* crossed out in each row form a word. All the words make a sentence. Write the sentence here.

____

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Vagina

Penis

Unfertilized Egg

Placenta

Sperm

Ovulation

Ovary

Testicles

Umbilical Cord

Uterus

Menstruation

Egg Tube

Sperm Tube

Fertilized Egg

Semen

Part Two

Cut out the Reproduction Review cards on this page. Each card has a word that you have studied.

1. Now sort the cards into two piles. One pile should contain the words that belong to the male reproductive system. The other pile will contain the words that belong to the female reproductive system.

   How many words do you have in your MALE pile?__________

   How many words do you have in your FEMALE pile?________

2. Take the cards that you have placed in the FEMALE pile. Now sort these cards into three piles.

   Pile A will contain the words that belong only with a PREGNANT FEMALE.

   Pile B will contain the words that belong only with a NONPREGNANT FEMALE.

   Pile C will contain the words that belong to PREGNANT and NONPREGNANT FEMALES.

   How many words do you have in Pile A?_________

   How many words do you have in Pile B?_________

   How many words do you have in Pile C?_________

3. What other words can you add to your cards?______________

   ____

   ____

4. Some high school students have thought of other ways to sort these cards. Can you think of any? If so, write them here.

   ____

   ____

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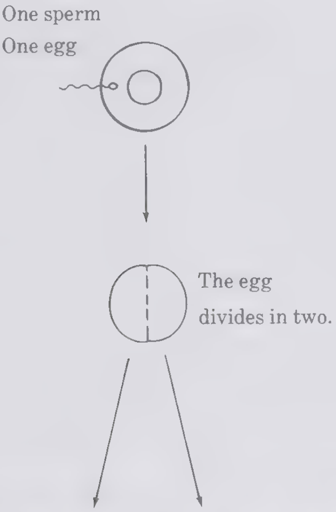
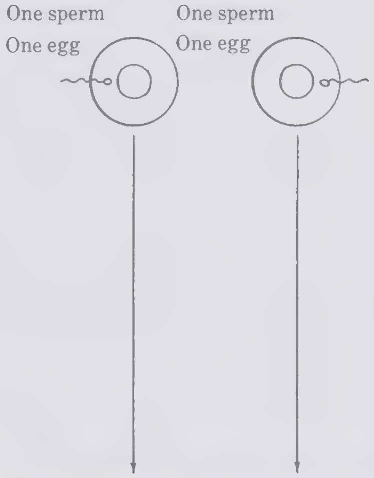
Chapter 13 Use Your Wits!

Part One

When scientists want to study inheritance, they often work with twins. There are two kinds of twins. If both babies develop from a single fertilized egg, they are **identical twins.** If the babies develop from two different fertilized eggs, they are **fraternal twins.** Fraternal twins may be as different as any two children of the same parents.





Identical Twins

Fraternal Twins

1. Which twins have the Same DNA in their cells: the identical twins or the fraternal? ________________
2. Can there be identical twins that have different sexes? ______
3. Can there be fraternal twins that have different sexes? ______
4. Why are identical twins so much alike? ________________

____

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5. What could happen after birth to make identical twins different from each other? ______________________________

____

____

6. What could happen after birth to make fraternal twins more alike? ______________________________________

____

____

Part Two

Match up the items in Column A and Column B. Write the letter of the best answer in the circle next to the number.

Column A	*Column B*
○ 1. DNA	a. an inherited trait that will show
○ 2. 46	b. X and Y chromosomes
○ 3. dominant trait	c. an inherited trait that may be hidden
○ 4. mutation	d. an inherited trait
○ 5. identical twins	e. carries the biological code
○ 6. recessive trait	f. rungs of DNA ladder
○ 7. determines sex	g. the number of chromosomes in human cells
○ 8. A-T-C-G	h. develop from one fertilized egg
○ 9. egg	i. a change in the DNA
○ 10. nearsightedness	j. the female reproductive cell

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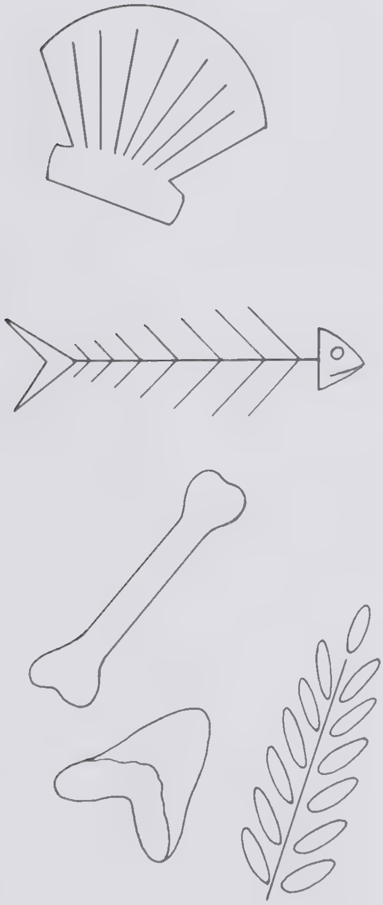
Chapter 14 Use Your Wits!

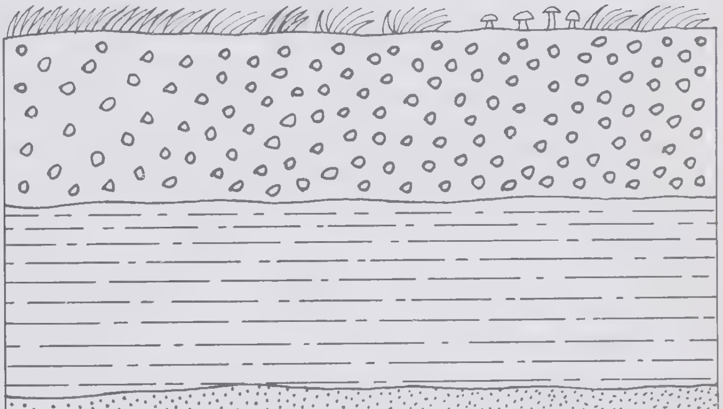
Part One

The five fossils shown below were found in different layers of rock.

The shell fossil is older than the fish fossil.
The bone fossil is from a modern horse.
The tooth fossil is from an extinct ancestor of the horse.
The leaf fossil is from the earliest known land plant.

Look at the diagram that has five layers of rock. Draw each of the five fossils in the layer where it was probably found. Be ready to tell why you think each one belongs where you put it.





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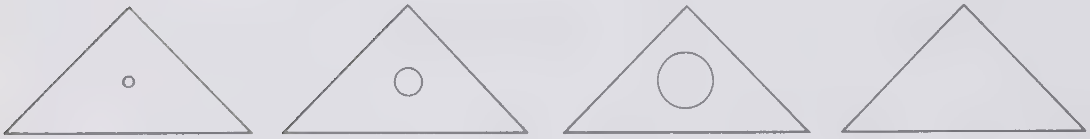
Part Two

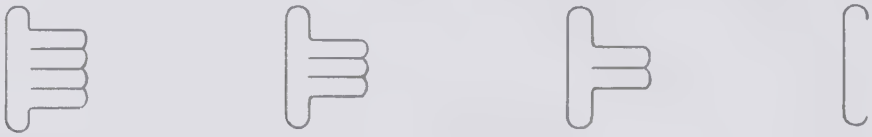
Pretend these shapes represent fossils. Use your imagination and draw the last change.

Compare your drawings with those of other people in your class.

A



B



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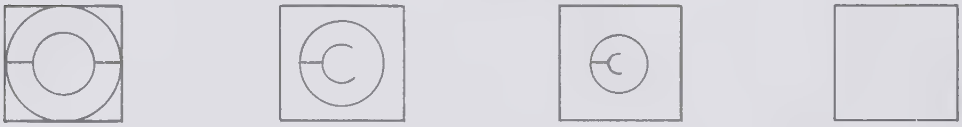
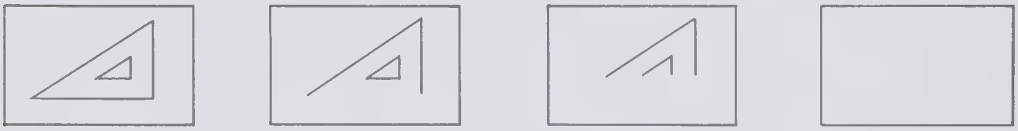
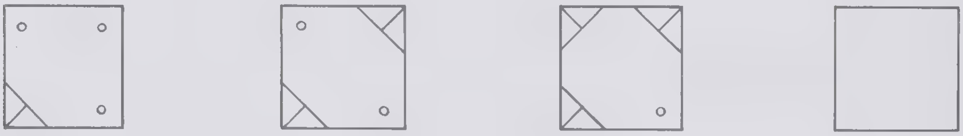


D



E



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Chapter 15 Use Your Wits!

THERE ARE 20 words hidden in the puzzle. They are all words that you used in the lessons on disease. The word STERILIZE has been circled for you. How many of the other 19 words can you find?

F	L	U	B	A	C	T	E	R	I	A	G
V	I	R	U	S	W	O	R	M	V	G	E
H	C	O	L	O	N	Y	S	J	A	A	R
A	N	T	I	B	I	O	T	I	C	R	M
M	A	G	N	I	F	Y	E	K	C	L	C
E	S	N	E	E	Z	E	R	N	I	S	O
A	P	R	S	T	U	P	I	V	N	K	L
S	C	O	N	T	R	O	L	B	A	I	D
L	D	O	C	T	O	R	I	C	T	N	I
E	S	I	C	K	I	I	Z	K	I	N	R
S	D	E	F	G	H	O	E	K	O	L	A
F	U	N	G	U	S	I	S	M	N	N	L

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Chapter 16 Use Your Wits!

Use this page to write down the things you think you should do to improve your health or to keep healthy. Check off each thing as you do it. You don't have to hand in this page to your teacher.

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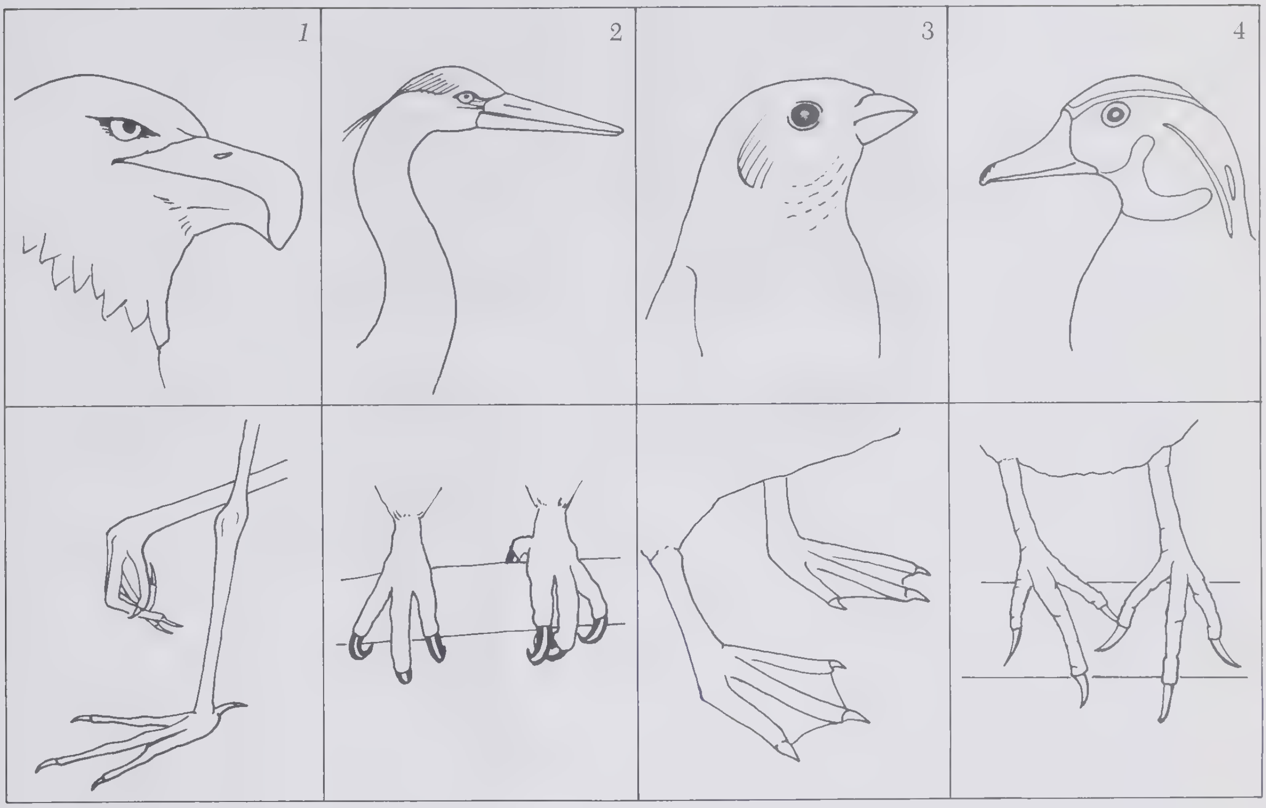
Chapter 1.9 Feathers, Bones, Beaks, and Feet
Part Three Beaks and Feet



	What it probably eats	The jobs its feet probably do
Bird 1		
Bird 2		
Bird 3		
Bird 4		

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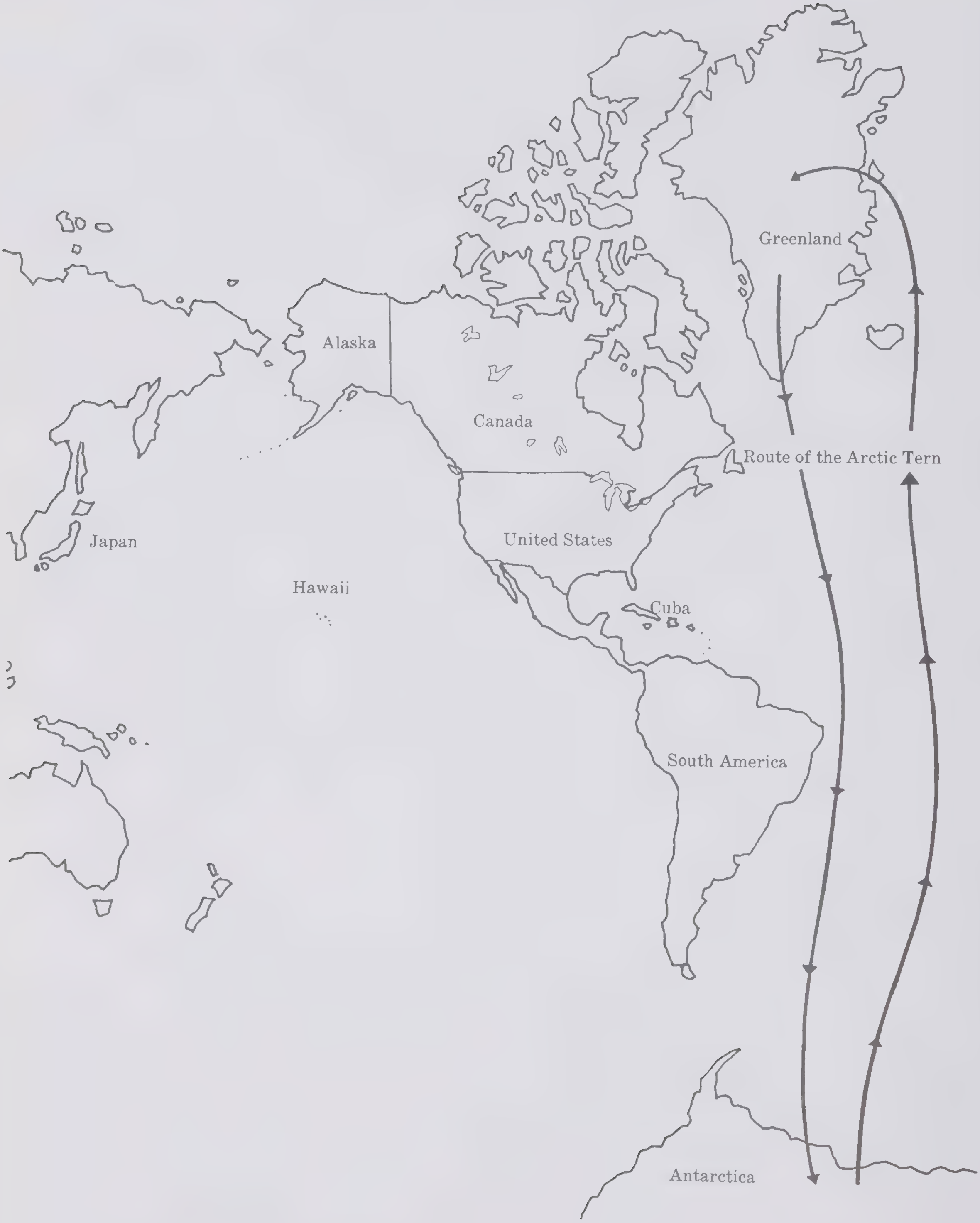
Chapter 1.11 Birds Don't Need Maps



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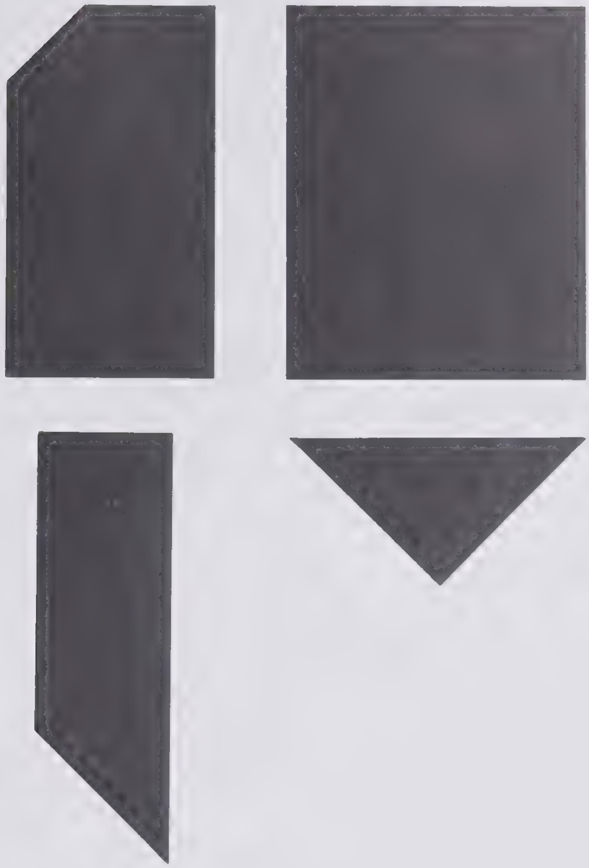
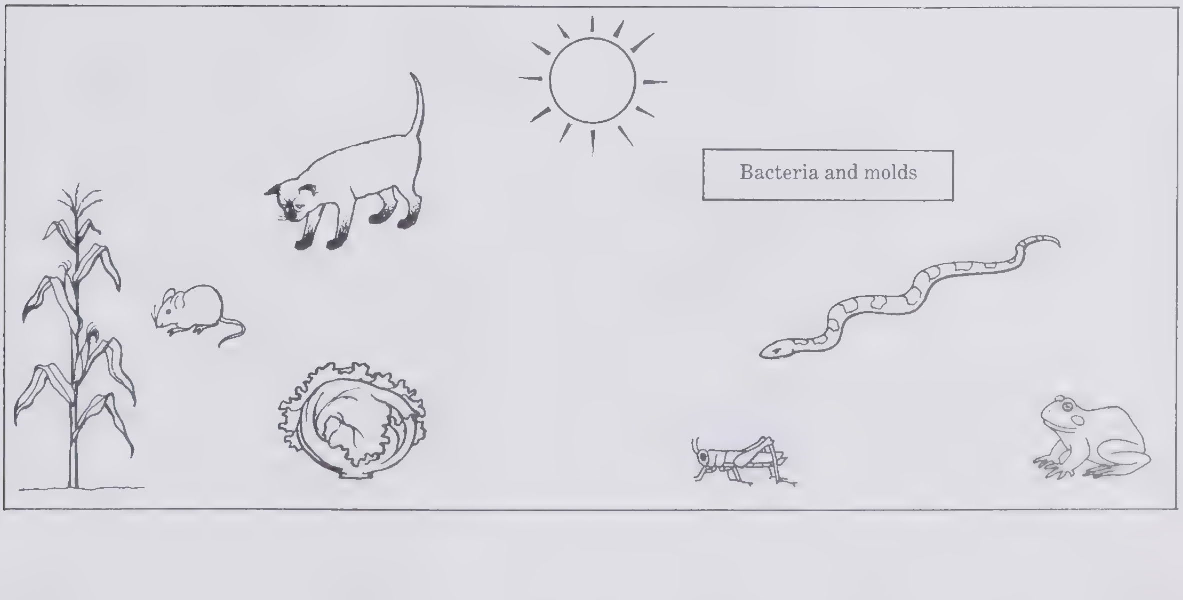
Chapter 2.5 Keep on Trying!



Chapter 4.1 Food Chains



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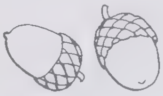
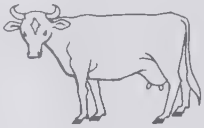
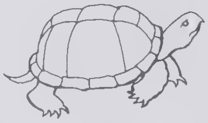
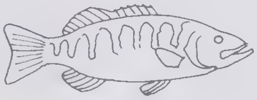
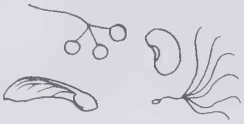
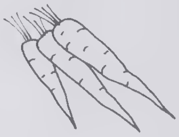
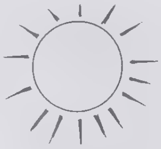
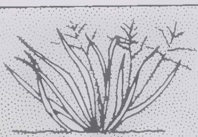
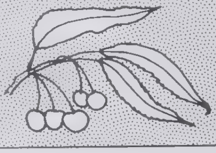
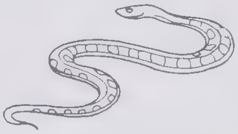
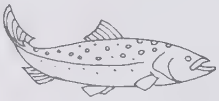
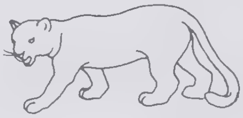
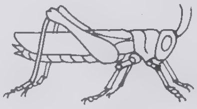
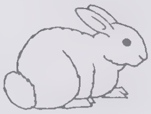
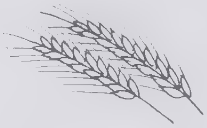
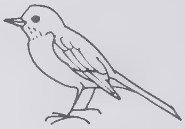
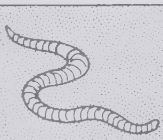
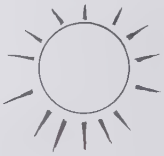
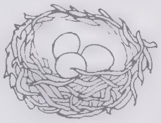
Chapter 4.2 Follow the Sun
Part Two Making Food Chains
Part Three Spin a Food Web

			
			
			
			
			
			
			
			
			Bacteria and molds

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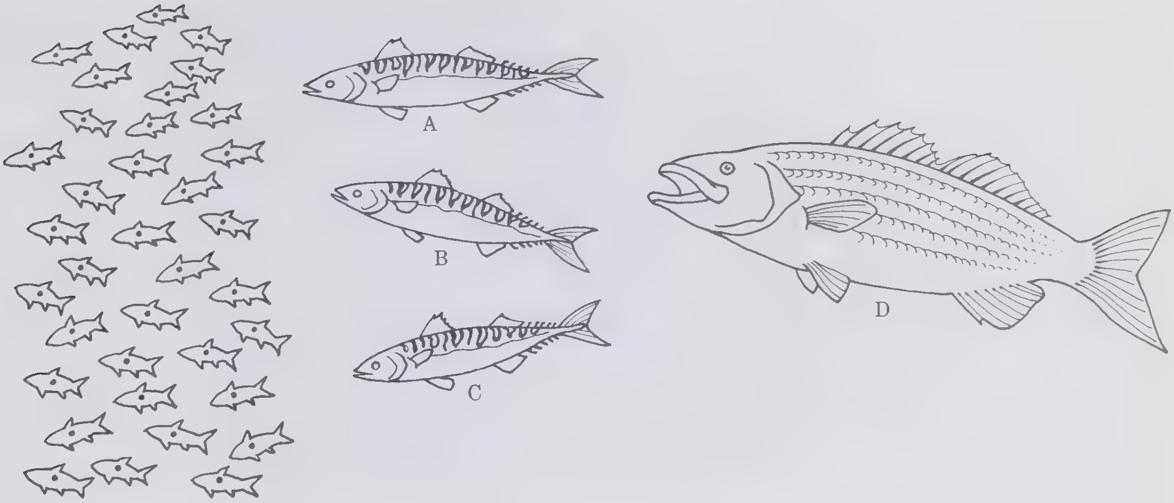
Chapter 4.2 Follow the Sun
Part Four A Build-up of Pollution



Chapter 5.3 The Compound Microscope
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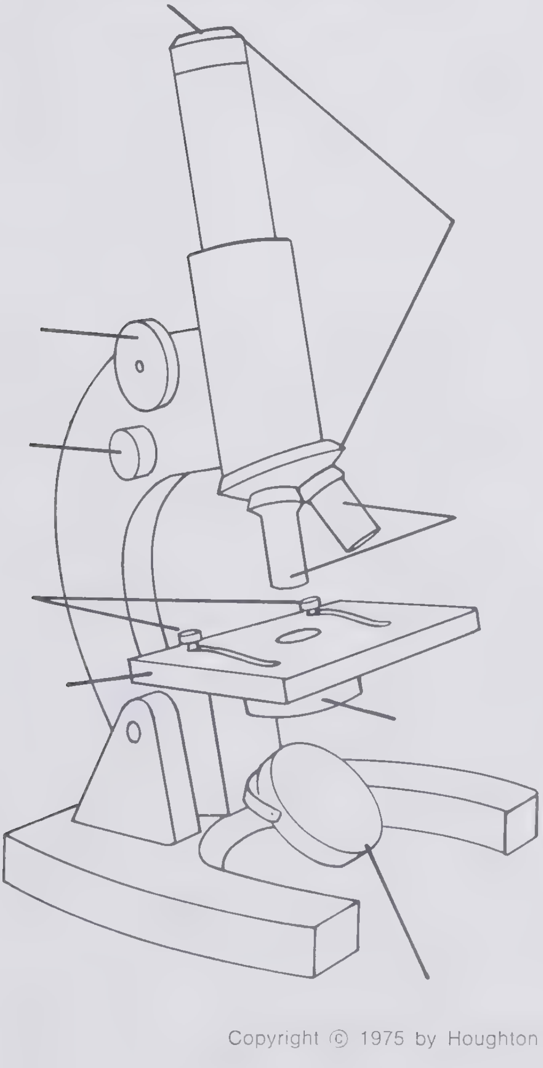

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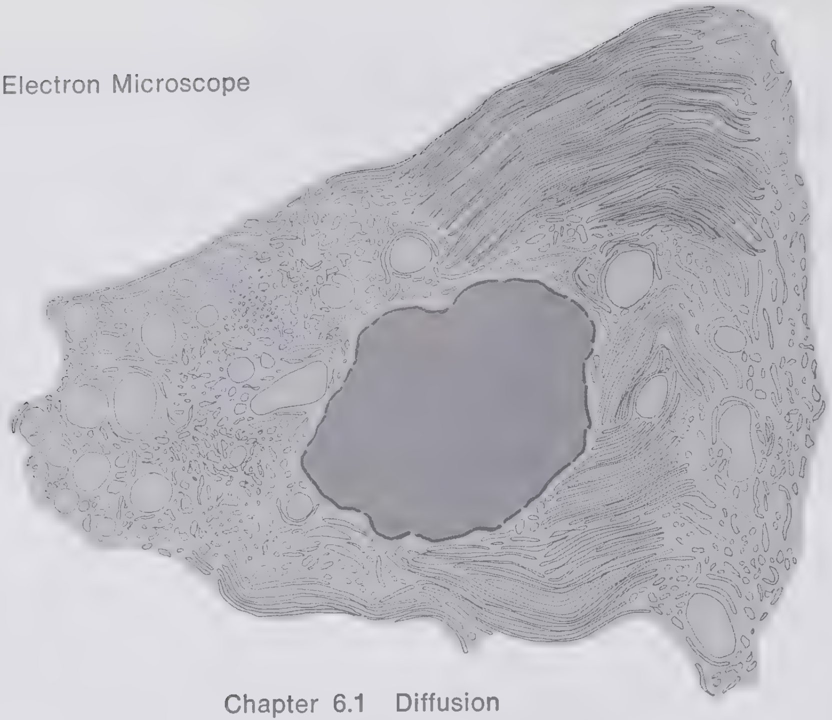
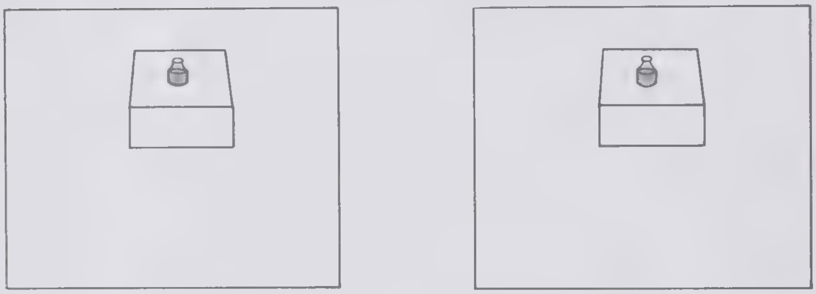
Chapter 5.10
Cells Under the Electron Microscope



Chapter 6.1 Diffusion
Part One The Invisible Traveler


After 4 hours

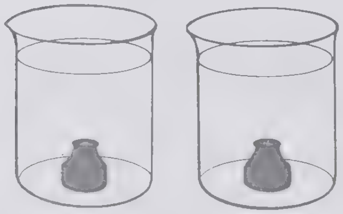
Chapter 6.1 Diffusion
Part Two Do Liquids Diffuse?

Show on these drawings what happens to the Kool-Aid.

After 1 minute After 5 minutes After stirring

Chapter 6.1 Diffusion
Part Three Seeing Red

Show on these drawings what happens to the ink.


After 3 minutes After stirring

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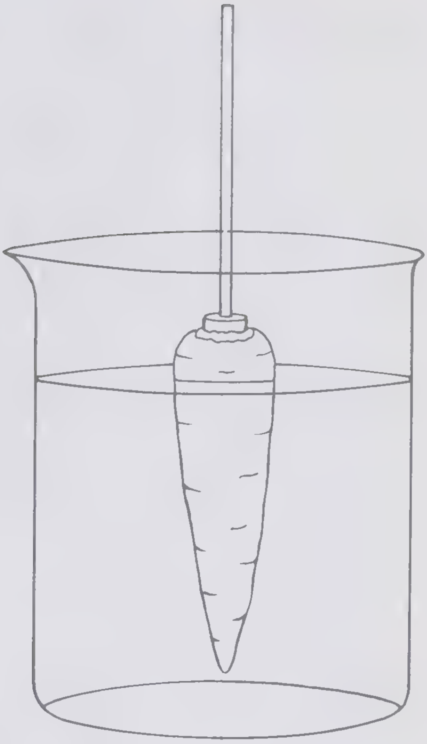
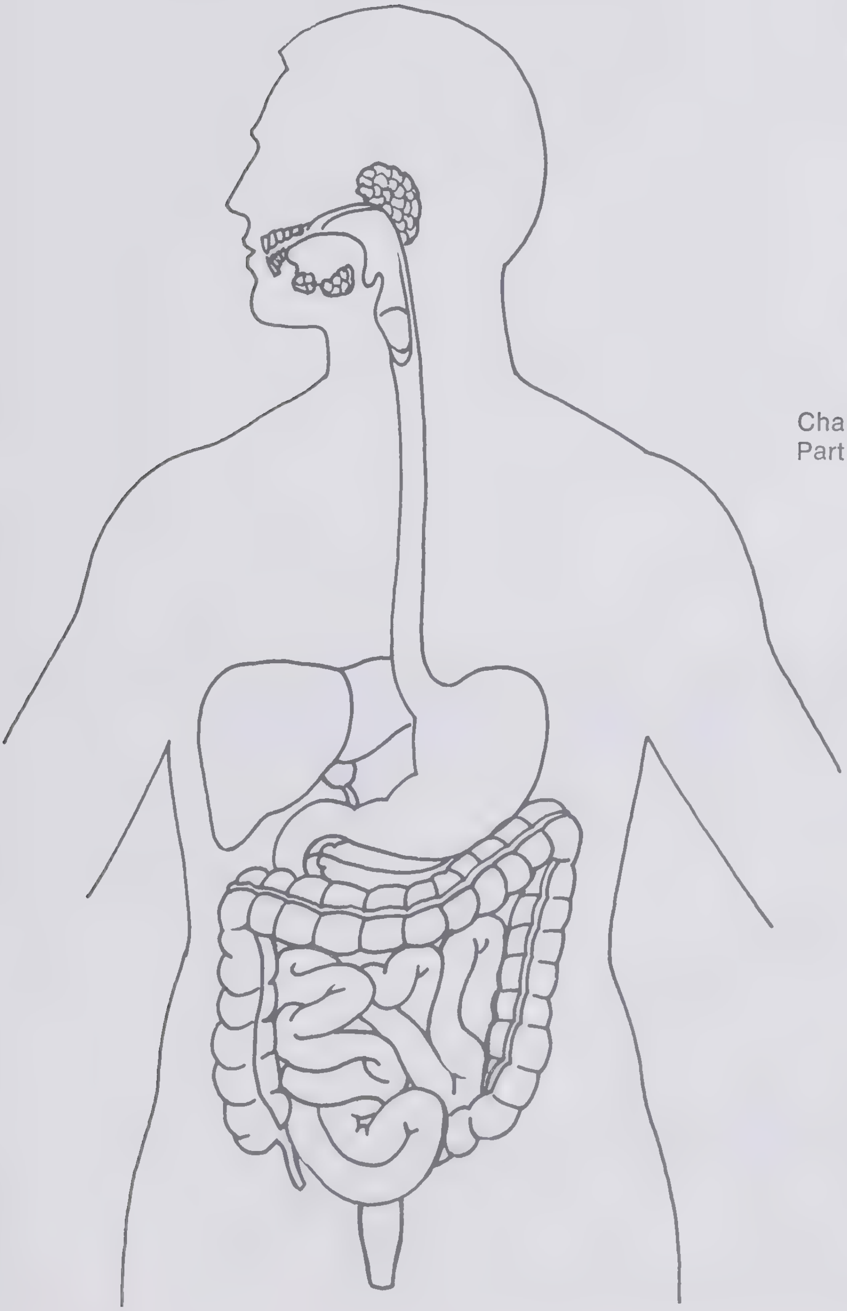


Chapter 6.1 Diffusion
Part Five How Do Roots Get Water?

Chapter 6.10 The Digestive System



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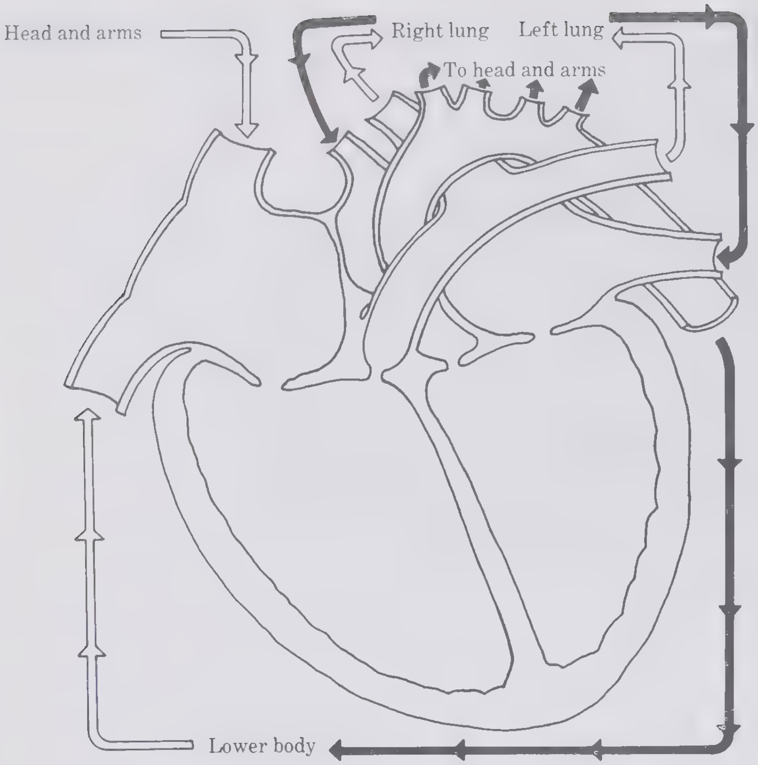
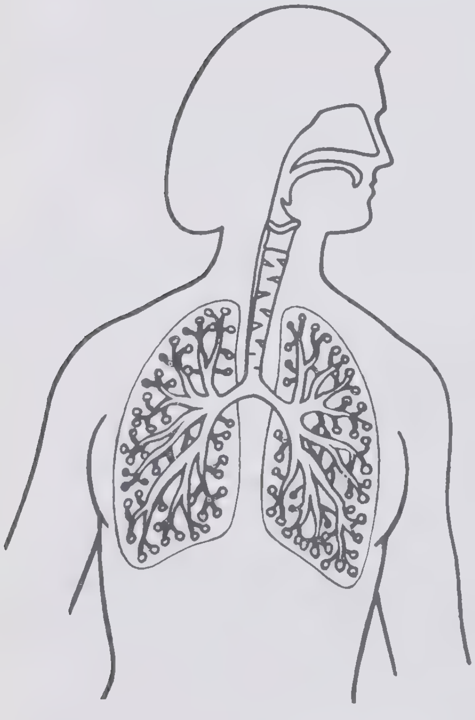
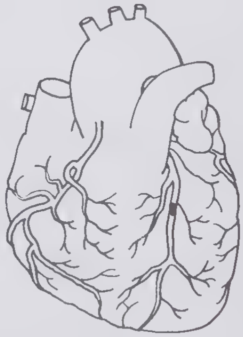


Chapter 7.2 A Look at the Double Pump



Chapter 8.2 Parts of the Breathing System
Part Three Airways



Chapter 7.2 A Look at the Double Pump
Check Yourself

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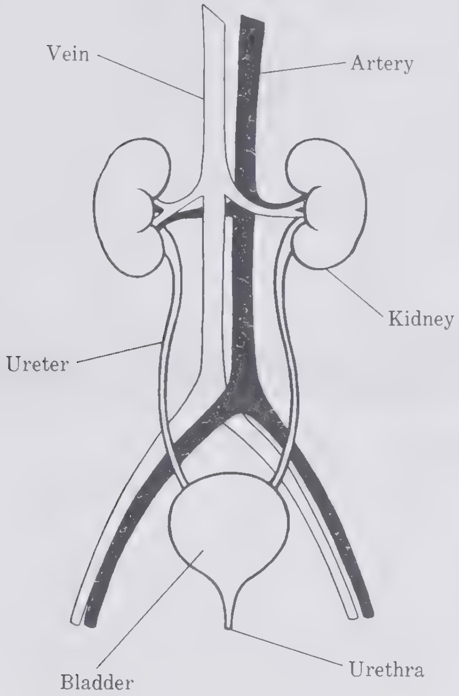
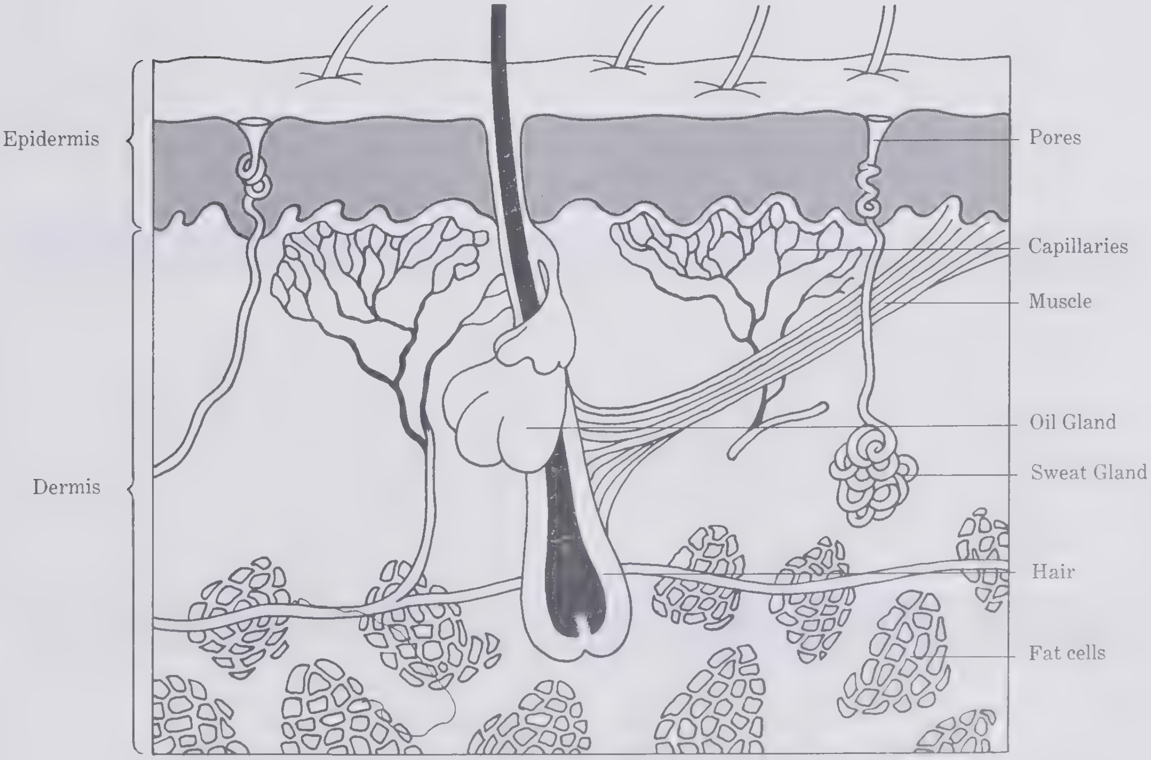
Chapter 9.2 The Living Filters
Part Two Human Kidneys



Chapter 9.4 The Skin
Part Two The Inside



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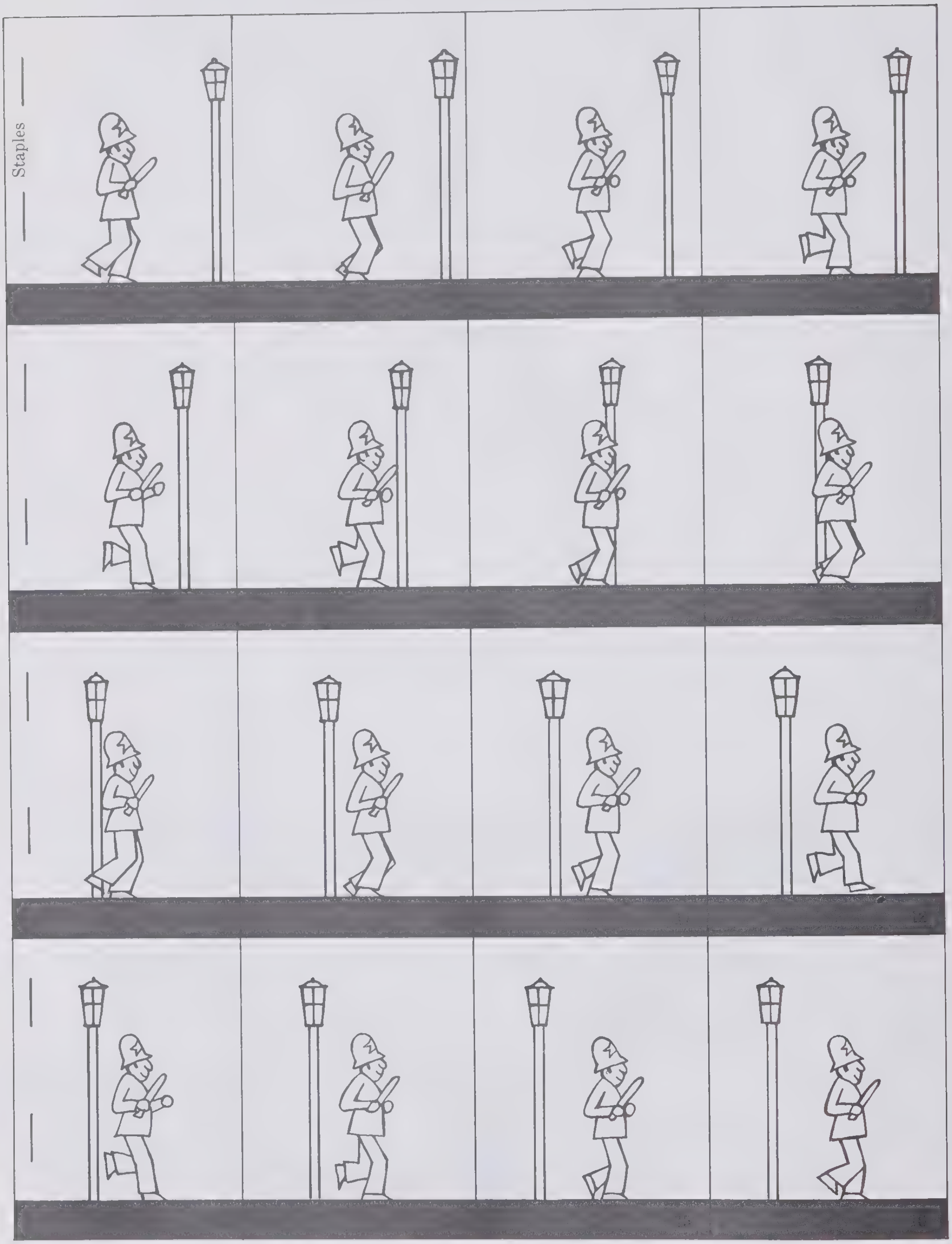
Chapter 10.3 Sensing the World
Part Three See It—Don't Believe It



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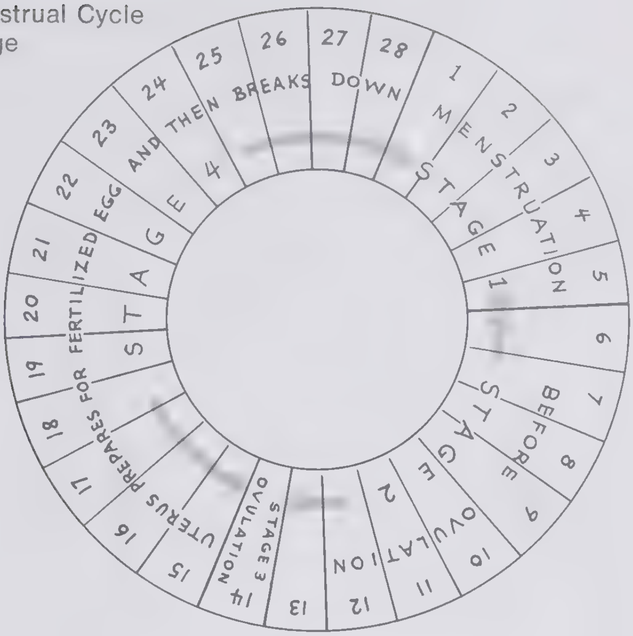
Chapter 12.12 The Menstrual Cycle
Part Two On the Average

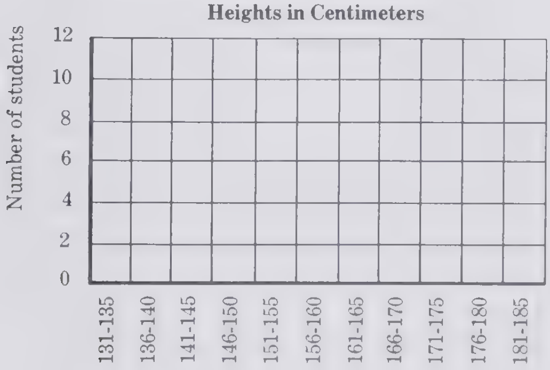


Chapter 12.12 The Menstrual Cycle
Part Two On the Average

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Chapter 13.3 We Come in All Sizes



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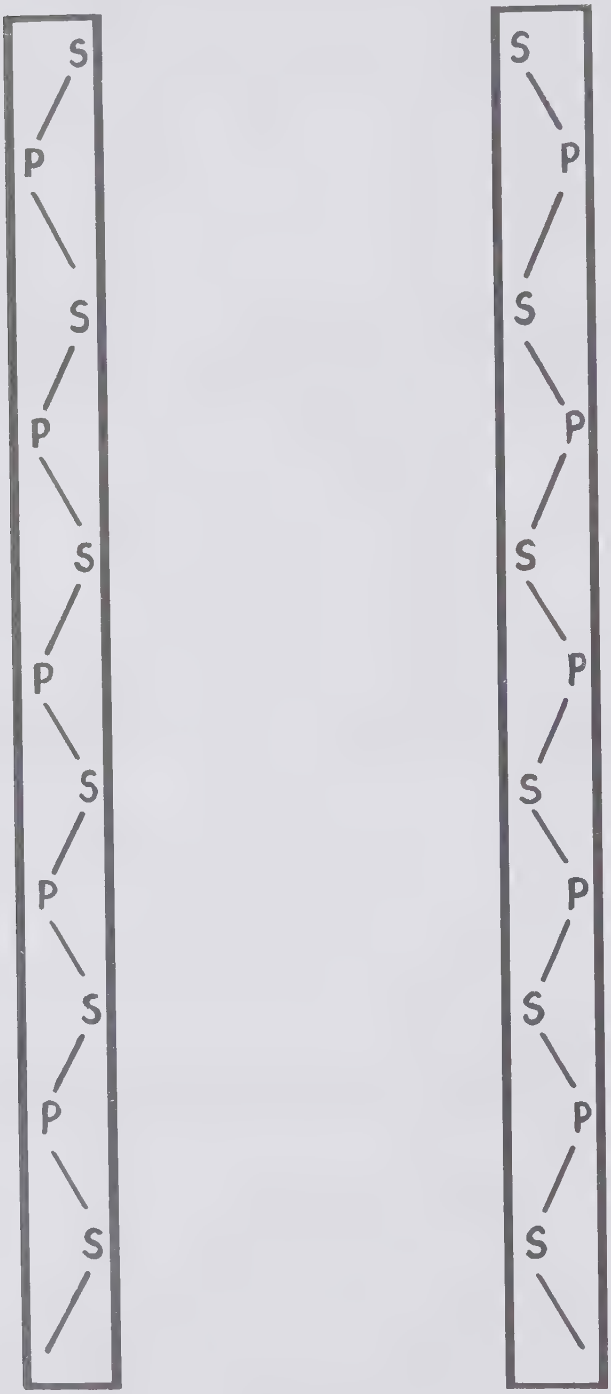
Chapter 13.5 Build Your Own DNA Ladder
Part One Putting in the Rungs



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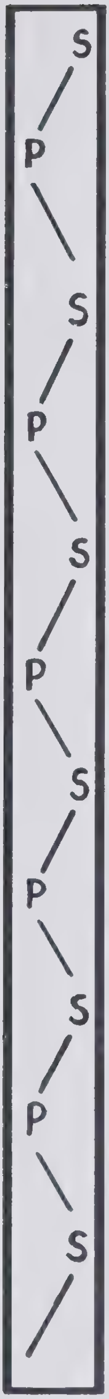
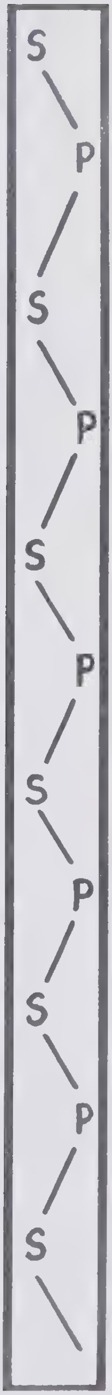
Chapter 13.5 Build Your Own DNA Ladder
Part Two Split It and Double It





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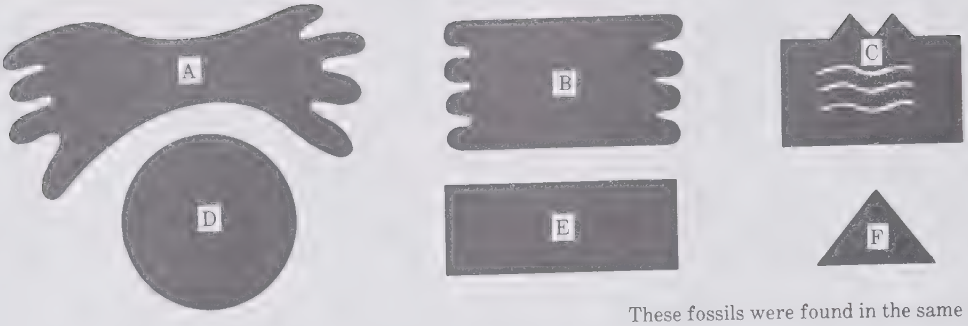
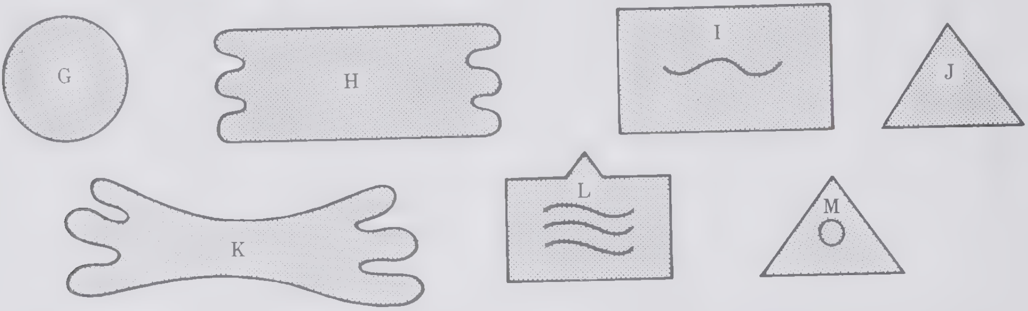
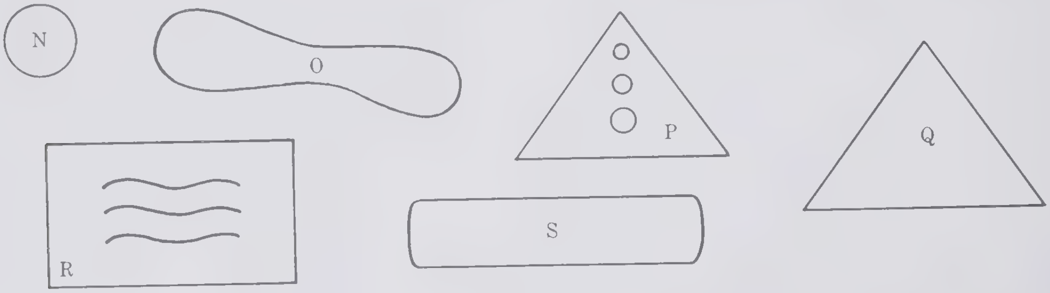
Chapter 14.4 Fossils and Evolution



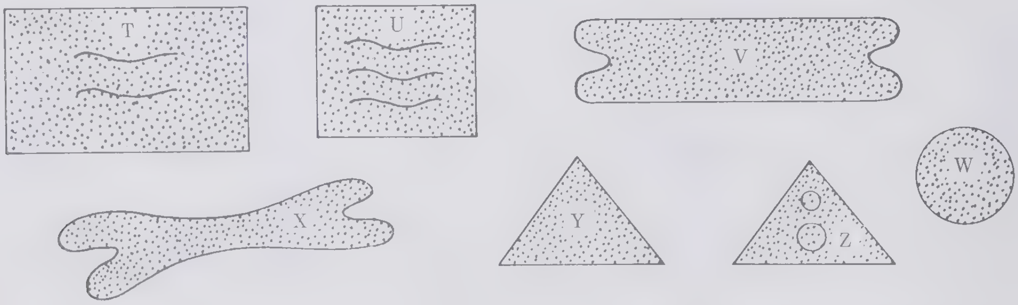
These fossils were found in the same layer of rock.



These fossils were found in the same layer of rock.



These fossils were found in the same layer of rock.



These fossils were found in the same layer of rock.

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Chapter 14.4 Fossils and Evolution

4

3

2

1

The oldest layer

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Chapter 15.2 Surrounded by Bacteria

Dishes		Source of Bacteria	Number of Colonies on Each Plate					
			Day 1	*Day 2*	*Day 3*	*Day 4*	*Day 5*	*Day 6*
Group 1	*A*							
	B							
Group 2	*A*							
	B							
Group 3	*A*							
	B							
Group 4	*A*							
	B							
Group 5	*A*							
	B							
CONTROL								

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LIFE

Activities and Explorations

Eleanor R. Fabiano
Eunice S. Liberson

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Hopewell, New Jersey Palo Alto

Each Exploration or Reading in the Teacher's Edition is introduced by an Overview, Behavioral Objectives, Materials List, and Timetable, as well as teaching notes. When the introductory matter runs long, the teaching notes begin on the following page. Page references in the margin with an H prefix, such as H 108, refer to the hard cover text. Page numbers with a T prefix, such as T 308, refer to the Teacher's Edition.

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Dedicated to the Students of Barringer High School

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Overview of Unit One How Plants and Animals Behave

Unit One introduces the area of biology most familiar to students—behavior. The students are encouraged to look at the world of living things with a new perspective, to search for patterns of behavior that reveal basic principles about how living matter interacts with the environment. They will also start to develop intuitive understanding of the scientific method and some basic skills in using it.

Probably most students will not be accustomed to the organization of the activities or the need to make accurate observations and keep accurate records. But the program begins on familiar ground and the students will be able to join in and contribute immediately.

The unit opens with activities involving relatively simple animals and their responses to stimuli such as light, temperature, food, water, and vibrations (Chapter 1). The Explorations emphasize inborn responses and the importance of these responses to the organisms in helping them get along successfully in their environment.

The structure of each Exploration is similar. Students observe organisms and record their observations. They are then encouraged to hypothesize informally about the behavior of organisms and to test their hypotheses. The concept of control is introduced immediately and constantly reinforced.

After activities on the simple behavior of insects, earthworms, and frogs, the program progresses to the more complex behavior patterns involved in hibernation, migration, and nest building. We purposely left out the terms reflex and instinct. You may wish to include them in your program.

Human behavior follows (Chapter 2). We start with inborn human responses, then introduce conditioning, habit formation, and other types of learning. Students enjoy learning about humans as organisms and will be outspoken in their remarks about themselves and their friends.

The idea of behavior as a basic characteristic of living organisms is extended in the activities on plants and their responses (Chapter 3). The stimuli used are touch, gravity, water, and light. Since plant behavior involves measurable changes, the metric system is introduced simply and naturally at this point. A working knowledge of the metric system will be useful to those students who enroll in additional science courses or find work in a laboratory. All students will benefit from this brief introduction when the United States changes over to the metric system.

Chromatography is presented as a technique to help students understand color changes in the fall foliage, but it is also a lesson in following directions and working carefully. Constructing graphs and, more important, the technique of reading a graph are taught in this Exploration. Enough material is provided to permit flexibility in the amount of time spent on graphing. (Additional material on graphing appears in the Teacher's Edition.)

While the class is waiting for plant growth and plant responses to take place, it will be necessary to plan ahead so that each period will contain an adequate amount of activity. Research You Can Do, Check Yourself, questions, Readings, Hall of Fame, or films will round out any period.

From working with plants and photosynthesis (you may have decided not to use this term) you can lead the class naturally into food webs (Chapter 4). Energy transfer and the transfer of pollutants from one trophic level to another are introduced next in the program. The first unit is completed by the introduction of living zones (biomes), including what we take the liberty to define as a "city biome"; populations, including a lesson in sampling a human population; pollution; and finally a study of the community in which students live.

In this chapter particularly, the activities attempt to relate to the students' needs and interests. Whenever possible we stress the problems of high schools, overcrowded neighborhoods, and of growing up in a complicated world.

The complementarity of structure and function is illustrated in several places in the material of Unit I. Without actually using the word evolution, you can introduce several basic related ideas by discussing adaptations that make it possible for plants and animals to succeed.

As we pointed out earlier, you can omit or shorten certain lessons without breaking the unit's thread of ideas and concepts. Take care, however, to avoid pressuring the students to stick closely to a predetermined time schedule. Let the members of the class set their own pace to the extent that this is possible in your particular situation.

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H 1

Unit One
How Plants and Animals Behave

1 Animal Behavior

Reading
1. Stimulus → Response

1. A MOTHER picks up her crying baby.
A roach runs away when a light is turned on.
A lion hunts a zebra.

2. What made the mother pick up her baby? The sound of the baby crying. Anything that makes you do something is called a **stimulus** (*STIHM yuh luhs*). The baby's cry was the stimulus that made the mother act. The light was a stimulus to the roach. It made the roach run away. The need for food was a stimulus to the lion. It made the lion hunt the zebra.

Any activity that is caused by a stimulus is called a **response**. The mother's act (picking up her baby) is a response. What was

Reading 1. Stimulus → Response

1. The words in the title may not be familiar to the students. Let the text explain the words as the reading progresses. Stop for a discussion or an explanation whenever it seems fit. Some students may know the word stimulant and assume that it can be used interchangeably with stimulus. To reinforce the words in the title, have the students suggest examples of stimuli and responses.

2. Try to include responses that are emotions or feelings that are not obvious to another person. You might ask, "How did you feel when you saw your schedule?" or "How did you respond when you learned what period you eat lunch?" or "How did you respond when you saw a friend in your class (or someone you don't like)?"

3. the roach's response to the stimulus of light? What was the lion's response to feeling hungry?

You should remember that all living things do not respond to the same stimulus in the same way. For example, some people enjoy listening to rock music. But some people hate it.

Plants and animals respond to things around them: heat, cold,
4. food, light, sound, and enemies. These are all stimuli. Together,
they make up the **environment** (*ehn VY ruhn muhnt*) of the plant
or animal. If the environment is changed, we often find a change
in the activities of a plant or an animal living there.

Your environment would include heat, cold, food, light, sounds, enemies, and friends. It would also include your block, your neighborhood, and your school. Can you see that many of your activities depend on the way you respond to the stimuli in your environment?

Which of these pictures shows a stimulus? Which shows a response?

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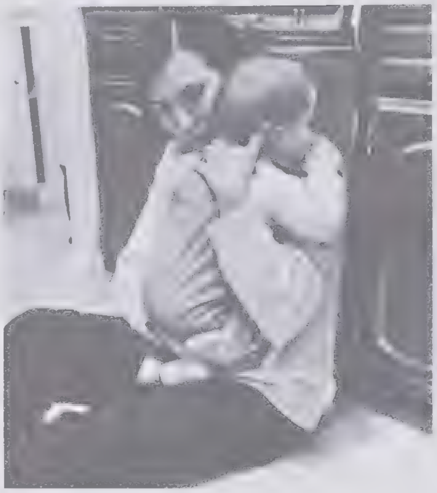

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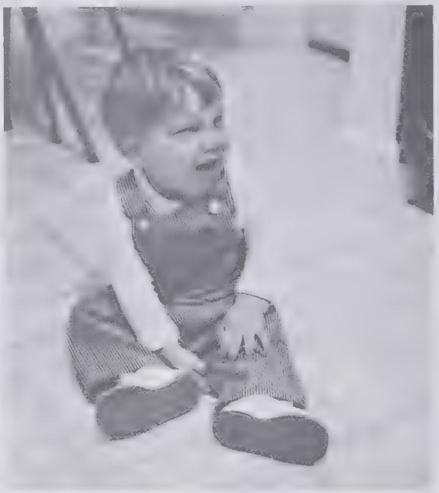

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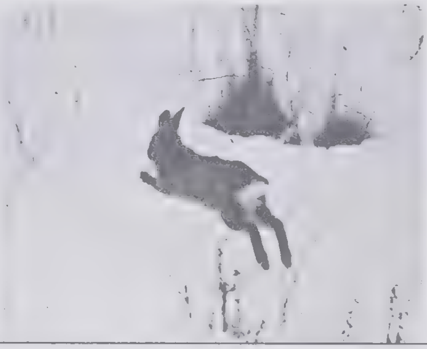

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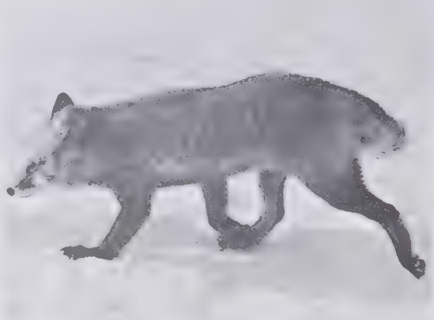


3. When you discuss the illustrations, show that they are not all simple stimulus → response situations, but that there may be a complex interplay. For example, the hungry fox chases a rabbit and a frightened rabbit runs from the fox. Also, the rabbit may be running for another reason and the two pictures are unrelated.

The baby's crying may have caused the mother to pick him up. Or the baby is crying because he was left on the floor by his mother. The baby may be crying for another reason. A good rule to follow in making stimulus → response pairs is don't jump to conclusions.

4. Although some students know the word environment, they may not use it in its broadest terms and may not be able to relate it to behavior. You might stimulate discussion by asking, "Suppose you came into the classroom and it was very hot, would it affect the way you act?" or "Do you ever behave differently for different teachers?" "Would having a different teacher and being in a different classroom constitute putting you in a different environment?" "How about changing your friends?"

Reading
2. The Insect World

1. INSECTS are all over the place. You find them in the city and in the country, in very hot places and in very cold places, in the air and deep under the ground. There are close to a million kinds. All of them have three pairs of legs, and most of them have two pairs of wings.

Many insects are so small that you don't notice them. They eat tiny bits of food that larger animals leave behind. Some insects eat strange foods like wood, glue, fur, hair, tobacco, and pepper. Most are able to go without water for a long time.

There are insects wherever there are people. Some of them eat our food, and our clothes, and even our homes. Some insects feed on our blood and carry disease. Many insects are useful to us. Bees make honey. The silkworm spins silk. Some insects help us by killing other insects that are harmful.

Because many insects are pests, we spend a great deal of time and money learning about them. We want to learn about them to stop them from harming us.

2. For instance, scientists have learned that the mosquito lays her eggs in water. The water may be in ponds, puddles, and streams.

Reading 2. The Insect World

1. Encourage the students to bring insects to class. Have insect cages or a supply of jars ready. Set aside any that can be used in the Exploration that follows. Ants are most appropriate for study of behavior but earwigs, roaches, termites, or flies can be used.

2. Point out that the old cans that fill up with water may be in a vacant lot in the city. Encourage the students to eliminate these breeding places of mosquitoes.

Mosquitoes even lay eggs in holes in trees or old cans that have caught rainwater. If we don't leave old cans lying around, mosquitoes can't lay eggs in them. If we put fish in a pond, they will eat the young mosquitoes in the water.

When scientists studied the behavior of flies, they found that some flies lay their eggs in garbage. So we know that garbage
3-5. cans should be kept covered. That makes it harder for flies to find a place to lay eggs.

Mosquitoes and flies do not plan where they will lay eggs. They respond to stimuli. They are born with certain responses built in.
6. They do not think about what they do, and usually they cannot change their way of responding.

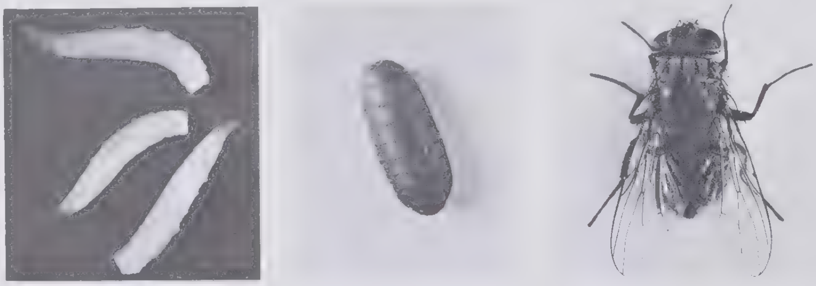
Some of the most interesting insects to study are the social insects. Ants, bees, and termites are social insects. They live in large groups called colonies, and they all share the work of the colony. You can read about them in *Exploring the World of Social Insects* by Hilda Simon.

In a bee colony, there are three different kinds of bees: The workers are females that gather food, clean the hive, feed the young,
7. and look after the queen. The queen is the only female that can lay eggs. She lays enough eggs for the whole hive. The males are called drones. One of them mates with the queen.

Nobody teaches each kind of bee what to do and how to do it. It can do its job as soon as it comes out of its egg. It doesn't have to learn its job, and it can't change its mind.

As we study an insect's behavior, we will see that it nearly always responds to the same stimulus in the same way. Watch for this as you do your laboratory work.

Three stages in the life of a housefly: larva, pupa, and adult. During the pupa stage the larva changes into an adult. Many other insects go through these three stages. A caterpillar is a kind of larva.



3. Maggots are familiar to most city dwellers but they may not associate them with flies.

4. Keeping garbage cans covered and keeping them clean is an activity that can be handled by the students.

5. Some students may realize that animal feces and dead animals may attract flies.

6. Reinforce the idea of stimulus → response as these words will be used throughout this unit.

7. The activities of bees make a fascinating story. They communicate by body movements called "dancing," they ventilate the hive, care for the queen and the young, drive out the drones just before winter comes, and pollinate flowers.

Exploration 3. How Do Insects Behave?

Overview

This may be the students' first experience in an activity-oriented situation. The students may not have handled living material before and may find the insects exciting. By taking advantage of their curiosity and interest, you can easily direct their activities. They will observe, collect information, and keep records. This may be their first exposure to the use of a control and can start their understanding of inborn behavior. This is where we start to build.

Remember that content is the least important part of the activity. Every small achievement should be encouraged. These students may have met nothing but failure in school and we want to break that chain.

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Exploration
3. How Do Insects Behave?

Responding to heat and cold, laying eggs, escaping from danger — all these things are **behavior** (*bih HAYV yuhr*). Behavior is any activity of living things.

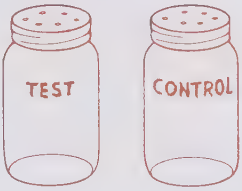
Today you will try to find out something about insect behavior. You will begin by seeing what stimuli insects respond to.

You will find the things you need for this exploration on your desk, or your teacher will give them to you. You will be working in groups. All the groups will do the first part of this exploration. After that, each group will be responsible for just one part. At the end of the period, you will tell the rest of the class what you have found out.

First get two covered dishes or jars. If your insect lives on or
1. under the ground, put a small amount of dirt in each jar. (Why do you have to do this?) Put half of your insects into the first jar and the other half into the second jar.

Write the word TEST with a wax pencil on the first jar. We will call the insects in this jar your test insects. You are going to do something to the test insects.

Write the word CONTROL on the second jar. We will call the insects in this jar your control insects. You are not going to do anything to the control insects. Keep the control jar where you can watch the insects in it.



Now, quietly watch your insects for a few minutes. What kind of insects are you looking at? Answers will vary.

What are the test insects doing? Answers will vary.

What are the control insects doing? Answers will vary.

Compare the activities of the test insects and the control insects.

Students record observations. There should be no difference between the two groups.

We can assume a cursory knowledge of insects and the variety of places in which they live. Most students are familiar with roaches. The students also know that this is the fall of the year and that insect behavior will be influenced by the colder weather ahead in most of the United States.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) define or describe a *control.*

(2) record and compare the activities of test and control insects.

(3) correctly answer questions about inborn behavioral patterns of insects.

Materials for Each Group

jars or covered dishes (12)
insects (ants are satisfactory)
wax pencils (3)
labels
flashlight or high intensity lamp
black cloth or paper 8 in by 11 in
food for insects (sugar or bread crumbs or bacon fat)
ice cubes (15 or 20)
pan (large enough to hold the insect jars)
hot water (60-65° C)

Time

Three days

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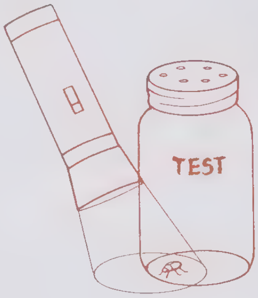
Group 1. Light's On!

2. **Part One**



This is a job for Group 1 only. Shine a beam of light into the test jar using a small lamp or a flashlight. Try to make one spot much brighter than the rest of the jar. Don't shine your flashlight into the control jar.

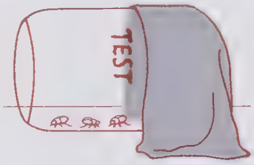
How do the test insects respond to the light? Answers depend on insects used. Ants will move away.

Do all your test insects respond the same way? Expect a yes.

What are the control insects doing? They will probably be moving randomly.

How does the activity of the test insects compare with the activity of the insects in the control jar? Test insects will show a definite response. Activity of control insects will be random.

3. **Part Two**



Be sure that the top of the test jar is on tight. Place the jar on its side and cover one end with a piece of black cloth or black paper.

Place the control jar on its side but do not cover it.

How do the test insects respond? Answers depend on the insect used. Ants will move toward dark areas.

Teacher Preparation

This activity is written as if the students are able to provide their own insects. Don't count on it! You should be prepared with enough insects for the class. Ants are easy to get even in a city lot. If anthills are not found on the surface of the ground, turn over rocks or boards to expose them. A small shovel can be used to scoop the ants into a large jar, soil and all. You may find eggs or larvae, too. Each of the three groups should have at least 20 ants to work with. Pill bugs, earwigs, mealworms, beetles, and roaches may also be found and used.

There should be no pressure on the class to work within a time schedule. If one group finishes its work before the end of the period suggest they help another. You may prefer, however, to have the early finishers start answering the questions at the end of the Activity.

This Exploration is easily handled by having three groups of students work simultaneously with the various stimuli. Another way is to have the entire class do the same thing at the same time. If the latter method is used, it is impossible to complete the work in one day. In classroom discussion be sure to stress the importance of the changing seasons in insect behavioral patterns. Where seasonal change is slight, alteration of behavioral patterns may also be slight. It is a good idea to have ready three trays of materials, one for each group, before the class comes into the room. Label each tray so each group can pick up its own material with no confusion between the different groups.

1. Start the Exploration by having everyone work to-

Why do you think they respond that way? They are responding to a stimulus.

Do you know of any other insects that respond to light in the same way? Other insects include roaches, bedbugs, termites.

Some insects show the opposite response to light. Name as many of these insects as you can. Almost any insect seen during the day.

4. **Group 2.** Dinner's On!

Part One

This job is for Group 2 only. Place some food in the test jar with your insects. Try to keep the food in one place.

What kind of food are you using? Answers will vary.

Do the insects seem to notice the food? Answers will vary.

Describe what the test group of insects is doing. Some insects may go toward food.

Remember the control group is in the other jar. What are the control insects doing? Moving about randomly.

Is this the food your insect would eat out of doors? Probably not, except at a picnic or around garbage.

gether. This gives you the chance to direct the first activity. Make sure the jars are marked properly and that the students know they are expected to write their answers in the spaces provided. Encourage them to use simple sentences. Accept the answers as they are written on the laboratory sheets. If possible, praise what is grammatically correct. As time goes on, there will be ample opportunity to help develop writing skills.

As the work in the individual groups progresses, circulate around the room, listening and asking probing questions. Avoid the temptation to reveal answers, but offer praise and acceptance for all progress observed.

Be sure to emphasize that intelligence does not play a part in any of the insect behavior observed in this activity. Do this as each group reports back to the class, or as you walk around the room while the class works.

Sometimes the unexpected will happen. For example, some ants may not respond to food. Perhaps they are carrying eggs instead, or the food is not a type they normally respond to. Use such occasions as learning situations. Let the students try to discover reasonable explanations.

Research should be handled on a voluntary basis, although books should be made available.

2. Group 1. Part One The light used should create a small bright light. Students might want to change the position of the light.

3. Part Two It is easier to put the black cloth over the end of the jar with the cover. This will create a dark side and a light side.

4. Group 2. Some ants will respond to grease (bacon or Spry) and some to sugar or bread crumbs. It is interest-

Part Two

If you have two kinds of food, do an experiment to find out which food your insect likes better. Explain what you did and what you found out. Answers depend on ideas of students.

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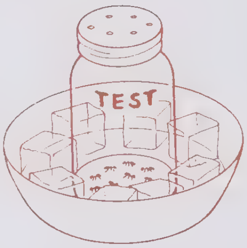
Group 3. Hot and Cold

Part One



5. Group 3, this is your job. Put the test jar in a larger pan or dish filled with ice cubes. Leave it for five minutes while you watch the way the test insects behave.

How do the test insects respond as the jar gets colder? Answers depend on insect. Ants may burrow into wet soil.

Compare the behavior of the test insects and the control insects. Remember that the control group is in your other jar. Test insects will show a definite response.

Part Two

Take the test jar out of the ice. Wait five minutes and then put the jar in a pan of hot water. Do this part of the experiment very carefully so that you won't get burned. Watch the test insects for a few minutes.

ing to try different types of food. If you are using other insects, the food may have to be changed. For example, earwigs feed on plants, mealworms need bran or cereal, and roaches can be fed almost any human food.

5. Group 3. Be sure the pan you use is large enough to hold the jar of ants and several ice cubes. Some youngster may want to use a thermometer to see how cold the air inside the jar gets. Encourage this. The hot water should be 60-65°C. If hot tapwater is not available, heat water in a pan and give it to the group as needed.

How do the test insects respond as the jar gets hotter? Insects become active. Ants may climb side of jar.

Compare the behavior of the insects in the test jar and in the control jar. Test insects will show a definite response.

Can you think how the responses to heat and cold might help the insects? Self preservation. They are moving away from danger.

Check Yourself

1. Why was it helpful to have the jar of insects that you did not test? (This was called the control.) For comparison. In an experiment it's helpful to know how the same animals behave when not under test conditions.

2. What is a stimulus? Anything that brings about a response.

3. What were some of the stimuli that you used in your experiments? Light, food, heat, and cold.

4. How did your insects respond to each stimulus? Refer to student's data.

5. Did the insects learn the responses that you saw in this experiment? Or do you think they knew how to respond to these stimuli as soon as they came out of their eggs? They knew.

6. Why do you think the insects responded as they did? The responses were inborn.

7. What conditions in their natural environment might affect the behavior of insects? Enemies, food, cold, light, and rain.

8. What is social behavior in insects? Give as many examples as you can. Living in large colonies and sharing activities. Bees, ants, and termites are examples.

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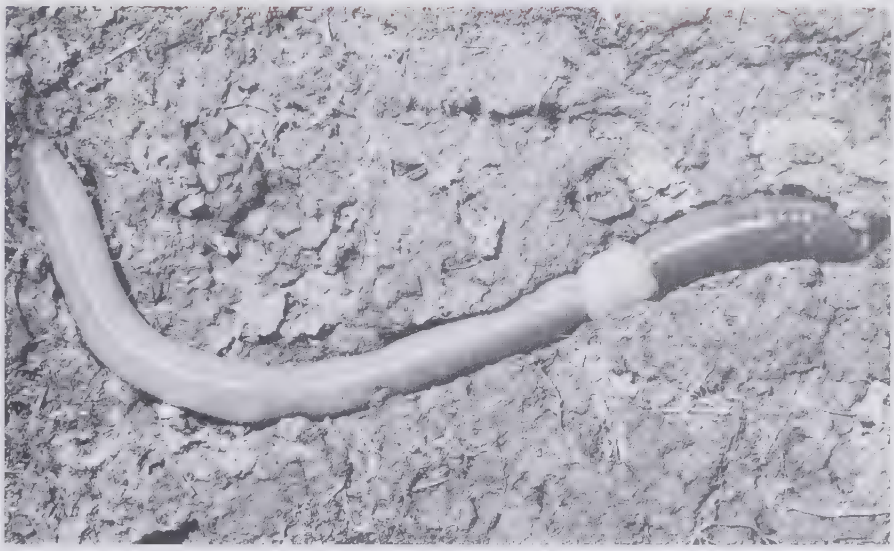
Research You Can Do

Are you interested in learning more about experiments and the people who plan them? If you are, look at the Biology Hall of Fame on page 478. Louis Pasteur, George Washington Carver, Jonas Salk, and other scientists are there. Read about one of these people. Then describe a famous experiment he or she did that used a control.

Reading
4. Life in a Subway



1-2. THE EARTHWORM lives in a subway under the ground. It makes its own tunnel as it moves about. Its body can open at both ends, like a tube, and dirt can pass through it as the earthworm moves.

3. The soil that the earthworm lives in is often mixed with seeds, very small live animals, and bits of dead plants and animals. This is food to the earthworm. So the earthworm lives in soil and gets its food from soil, too. The food is taken from the soil as it moves through the worm's body tube. There are special parts of the tube for doing this job.

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The earthworm does some of the things that a farmer does. It loosens the soil as it burrows, just as the farmer loosens the soil with a plow. Farmers add fertilizer to the soil to make plants grow better. Earthworms fertilize the soil by mixing their own wastes

Reading 4. Life in a Subway

1. If your students do not live in a city that has subways, it is a good idea to be sure that they understand the title of this Reading.
2. If your students do live in a city that has subways, be sure that they understand that the earthworm makes its own subways. Ask them what they think the title means.
3. Remember that the Exploration is the important activity, so don't linger over the Reading.

with the soil. The mixing is done inside the body. When the mixture is put out, it helps plants grow better.

An earthworm has no nose and no lungs; it breathes through its skin. But the earthworm's skin must be moist or it cannot breathe. So we find earthworms in damp ground. If there has been no rain for a long time and the earth dries up, the worms will burrow deeper, looking for dampness.

When you look at an earthworm, you will see that the body is divided into rings, or segments. The earthworm and all its relatives have these rings. Rings are one way of telling this group of worms from other groups of worms.

You will find small stiff bristles on the earthworm's body. The earthworm uses these bristles to grip the ground when it is crawling. It can also use them to hook itself onto the sides of its tunnel so that it is hard to pull the earthworm out. You may have tried to pull an earthworm out of the ground. If you have, you know how tightly it can hold on.

The earthworm does not have eyes, but the skin at both ends of its body responds to light. The earthworm does not respond to sound, but it responds very strongly to vibrations in the ground. It does not have much sense of smell.

4. What do you think people did to find out these things about earthworms? They experimented with thousands of earthworms.

You learned that an insect's responses to stimuli help it to stay alive. Guess how the earthworm might respond to stimuli in its environment. Write your guesses in the space below.

Stimulus	Response (Your Guess)
	Let students speculate.

4. The Exploration will direct the students to go back to their guesses about the earthworm's responses, so be sure to take a few minutes to have the guesses written at the end of the last paragraph.

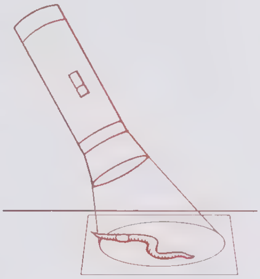
Exploration 5. How Do Earthworms Behave?

Overview

In this Exploration the students will have a second opportunity to make observations and record information—two of our general objectives. They will use a different animal, the earthworm, and some of the same stimuli. They will follow instructions and will begin to understand the importance of having only one variable in each experiment.

The recognition of inborn behavior will be reinforced, and again the student should avoid attributing conscious thought to the reactions of the worm. For this Exploration, the students will work in three groups.

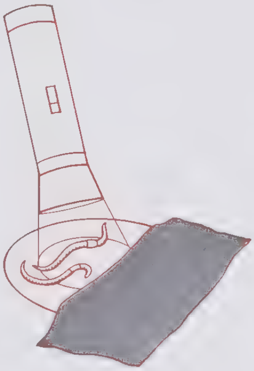
Exploration
5. How Do Earthworms Behave?



1. Today you are going to look at the earthworm. You will work in one of four groups. At the end of the period, each group will make a report to the rest of the class.
   You have to take an earthworm out of its burrow to watch it, so remember to keep its body damp. Keep your worms on a wet towel.

2. Everybody will do this. Keep the room as dark as possible. Watch your worms for a few minutes. What are they doing? **Answers will vary.**

   Shine a light on your worms. Use a flashlight or a small lamp. How do your worms respond to the light? **They move away.**



   Now cover half of a large dish with black paper or black cloth. Put the worms on the uncovered side. Shine the light on the uncovered side of the dish.

   How do your worms respond now? **They will probably move to the dark side.**

   Move the black cover to the other side of the dish. Again shine the light on the side that is uncovered. How do the worms respond?

   They will probably move to the dark side.

   How could this response help the earthworm? **It helps them find their way into the soil or under leaves.**

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) observe and record earthworm responses to various stimuli.

(2) correctly answer questions about the inborn behavioral patterns of earthworms.

(3) explain the survival value of one or more of the earthworm's responses.

Materials for Each Group

flat dishes or pans
earthworms (10-15)
paper towels
flashlights or high intensity lamps (5)
black cloth or paper (5 pieces)
rulers
board, shelving or breadboard (40 cm long)
tuning fork
ice cubes (5-6)
hand lens

Time

Three days

1. The larger the worms the easier they are to observe. If worms can't be found by digging for them, they can be purchased at a bait store or ordered from supply houses. Allow sufficient time for delivery if worms are to be ordered.

Why did you move the black cover to the other side? To double-check answer by comparing sides.

3. Group 1. Touch and Go!

This job is for Group 1 only. You will test the earthworm's reaction to touch.

Part One

Watch the worms for a few minutes.

Does each worm stay by itself, or do the worms stay in a group? Record observations. They usually stay in contact with something.

→ H 13

Put each worm in a different place on the dish. How do the worms respond? Answers will vary.

Does the worm seem to have a front end and back end? Yes.

How can you tell? The worm's front end becomes thin and pointed as it moves forward.

Part Two

Give your worms a chance to be near a pencil, a ruler, or the edge of a dish.

What do you notice about their behavior? Answers will vary. Worms may stay in contact with ruler.

Don't insist that reluctant students touch the worms. Move around the room as the groups are working. Avoid giving answers. Urge the students to record what they observe, not what they think you want them to observe. Set up trays of materials for each group before the class enters the room. Label the trays so each group can pick up its own material with a minimum of confusion.

2. Make the room as dark as possible for this part of the lesson. A light that will make a small bright spot should be used. Allow enough time for students to adjust the light.

3. Group 1. If there are extra worms, put them in the dish belonging to this group. It will be easier for them to see the tendency of the worm to stay in contact with something. The head end has a small half segment at the tip and is closer to the girdle (clitellum) than the tail end.

4. Group 2. The worms are put on a wet board for this part of the lesson. You might ask group 2 why they use a board and why the board is moistened. Remember that an earthworm must be kept damp. The tuning fork should be struck with its hammer, not banged on the desk.

Press your finger gently on the body of a worm. Does it seem to feel the touch? Yes. How can you tell? There are various ways to tell.

Does the worm's body respond to touch all over? Yes.

Which part responds most strongly? The head. How did you test this? Record how this was tested.

---

4. **Group 2.** Good Vibes

Group 2, your job is to test if earthworms respond to vibrations. Place your worms on a damp board while you test them.

Part One

Tap the board with a ruler or a pencil.

Do the worms respond in any way? Yes. How do they respond? Answers will vary.

Do you think that the worm can tell when another animal is coming close to it? Probably, yes.

Do you think the worm hears the other animal? No, it probably responds to vibrations. Can you see any ears on your worms? No ears can be seen.

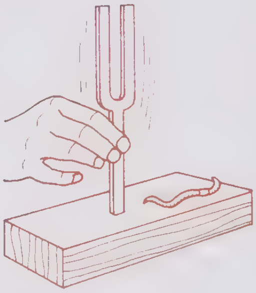
Part Two

Keep the worms on the damp board. Strike a tuning fork with a hammer to make it vibrate. Hold it near the worm.

→ H 14

Do the worms respond in any way? Yes. How do they respond? More vigorously.

Does any one part of the worm's body seem to respond more strongly than the other parts? Answers will vary. How can you tell? Place tuning fork close to various sections of the body.



Part Three

Strike the tuning fork and touch the handle of it to the board that the worms are on.

Do the worms respond in any way? Answers will vary. How do they respond?

How could this response help the worm? The worm is able to detect vibrations in the ground.

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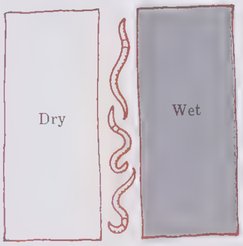
5. Group 3. Wet or Dry?

Group 3's job is to test the response of the earthworm to dry and damp places.



Part One

Put a wet paper towel and a dry paper towel close together on a desk. Put two or three earthworms between the towels. Watch the worms for a few minutes.

How do the worms respond? Worms usually move onto or under wet paper.

5. Group 3. It is possible to hear the scraping of the setae and to feel them by running the fingers up and down the body of the worm. A magnifier makes it possible to see them. You may have to hold the worm while it is being examined as some students are not quite ready to pick it up.

Do they move toward the wet towel or the dry towel? The wet towel.

Do the worms seem to have a front end? Yes. What makes you think so? One end becomes thin and pointed as the worm moves in that direction.

Why do we have to dig very deep to find earthworms during a dry spell? They move deeper to find dampness.

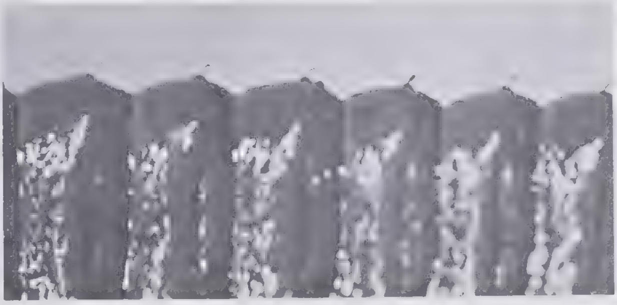
Part Two

Put an earthworm on a dry paper towel. Put your ear down close to the desk top, next to the worm. Listen as the worm moves. The class should be quiet while you are doing this.

What do you hear? Scraping noise.

What do you think makes this sound? Rub your finger over the body of the earthworm or use a hand lens to help you answer this question. Small stiff bristles.

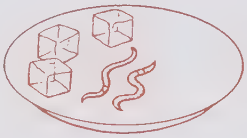
The picture on the left is a close-up of a worm's skin. Have you ever seen a robin pulling up a worm? Why can it be hard work?



Your worm is on a dry towel. How does the earthworm behave in a dry place? Answers vary.

→ H 15

Group 4. Out in the Cold



Group 4, your job is to test how earthworms will respond to a cold environment.

Put three ice cubes in a large dish with your worms. Watch the worms for a few minutes.

How do the worms respond? Answers vary.

If you move the worms close to the ice, what do they do? They usually move away.

Can you tell which is the head end of the worm? Yes, the head end becomes pointed and thin as the worm moves forward.

Which end of the worm responds more strongly to the cold, the head end or the back end? ______ What makes you think so? Record observations and conclusions.

Why would you have to dig very deeply to find earthworms in the winter? They burrow deeper to avoid the cold.

Check Yourself

1. How did the earthworms that you tested respond to these stimuli?

Light	Use students' data.
Cold	
Dampness	
Vibrations	
Touch	

2. Now look back at the guesses you wrote about your earthworms' responses on page 14. Were your guesses the same as the answers you found in the experiments? Answers will vary.

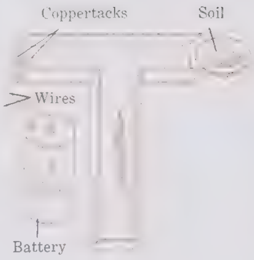
3. Here are five stimuli. How does the earthworm's response to each one help it to get along in its environment?

Light	Helps it find a dark environment.
Cold	Helps it avoid cold.
Dampness	Helps it keep body moist.
Vibrations	Helps it detect approaching animals.
Touch	Helps it avoid danger.

4. The earthworm has no eyes or ears. How does it get along without them? It is sensitive to light and vibrations through the skin.

5. Why do we often see earthworms on the sidewalk after a heavy rain? The rain floods their tunnels.

6. How is the earthworm important to us? It keeps soil cultivated and aerated.



Research You Can Do

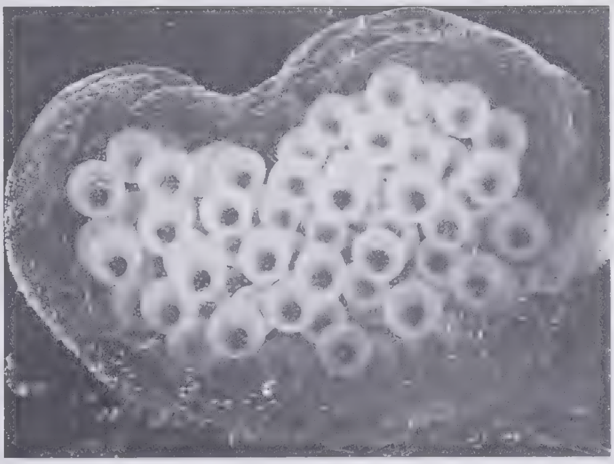
Most of the earthworm's behavior is inborn. However, some biologists have taught earthworms to avoid an electric shock. You can do this experiment by setting up the equipment shown here. This experiment will take several days to finish. Can you tell why?

Can you think of an experiment to find out which end of the earthworm responds more strongly to light? Try out your experiment if you can.

There are some good ideas for experiments with earthworms in *Experiments in Animal Behavior* by Marguerite D. Hainsworth.

Reading

6. Frogs Don't Freeze



Frog's eggs

Scientists often split things up into groups or sets that are alike in some ways. This makes it easier to study them. For example, biologists group animals into those that have bony skeletons inside the body and those that do not have skeletons. You have studied two animals that don't have inside skeletons, insects and earthworms.

1. Now, for the first time, you are going to study an animal that has an inside skeleton, just as you have. Animals that are built this way are called **vertebrates** (*VUHR tuh brihts*). The frog is a vertebrate.

2. A frog's body is built to help it get along in its environment. It has long, strong legs so that it can jump quickly. It has webs on its feet so it can swim. The color of its skin helps the frog to hide. A frog gets along by hiding, or jumping, or swimming away from its enemies.

In the spring, frogs lay hundreds of eggs in the water. After a few days, the eggs hatch into young frogs called tadpoles. Tadpoles are something like fish. They breathe with gills and must

Reading 6. Frogs Don't Freeze

1. Since we introduce the word vertebrate here, bring a frog skeleton into the classroom. You might bring any others that are available. Don't go into much detail with the skeletons. You may want to ask the students to list 10 animals that are vertebrates.

2. Remind the students that they learned that an earthworm will die if its skin dries out. We are saying the same thing about the frog.

live in water. Their bodies slowly change into a form that can live on land. Then they are adult frogs. Frogs have lungs and can breathe air. They have legs and can move on land. Yet they can't get far away from the water because they will die if their skin dries out.

When winter comes, the air and the water get colder. The frogs respond to this change by digging into the mud at the bottom of the pond or stream. They stay in the mud without moving or eating until the next spring. The only food they have is the food already stored in their bodies. The only air they get is the small amount that passes through their skin. (Does this remind you of the earthworm?)

3. The frog's response to winter is called **hibernation** (*hy buhr NAY shuhn*). Hibernating is inborn behavior in the frog. If a frog doesn't hibernate, it freezes or starves to death during the cold months. Hibernation helps a frog to live through the winter.

A good book on frogs is *Amphibians and Their Ways* by H. Rucker Smyth. You might find it interesting reading.

3. The class may know about bears hibernating, but this is not true hibernation. On a warm winter day, bears may stir and go about looking for food. A frog truly hibernates.

Exploration 7. How Do Frogs Behave?

Overview

Observations on the frog will add a dimension to the understanding of inborn behavior. The idea of hibernation is added, and it should be made obvious to the class that this behavior is much more complex than any they have seen so far. After observing the effect of cold on the frog's breathing rate, students will get the idea that hibernation slows down life processes.

Even if the class did not do the activity on the earthworm's behavior, they should be able to discuss inborn behavior and be ready to understand hibernation. Students recognize frogs, although they may never have seen or handled one.

Exploration
7. How Do Frogs Behave?

Today you will observe frogs and find out all you can about their behavior.

At the front of the room are five frogs that have been in ice water for about a half hour. There is also a frog in water at room temperature. This water is deep.

On your desk are two jars with frogs that are in a small amount of water. Mark one of these jars by writing CONTROL on it and put it somewhere safe on your desk. The frog in the other jar will will be your test animal.

You will work in groups. This time each group will do Parts One, Two, and Three.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) give two or more examples of how the frog's external anatomy helps it survive in its environment.

(2) record and compare the activities of test and control frogs.

(3) define or describe *hibernation*.

(4) explain how the frog responds to cold.

Materials for Each Group

frogs
jars (large)
wax pencils
pencils
vinegar
paper towels
forceps
earthworm or mealworm
stop watch (wrist watch)

Time

Three days

Teacher Preparation

Students have now completed three activities which gave them some experience performing in a lab. Now is a good time to check their achievements. Don't expect too much. However, they should show some progress in

1. Part One The Hideout

What is the frog in the deep water doing? It's usually floating with eyes and nostrils exposed but may be sitting on the bottom.

How could this help the frog? The frog can see and breathe while the body is underwater.

What is the test frog doing? Probably sitting.

How could this help the frog? Back legs are ready to jump. It can see around and is in a good position to catch food.

Look at the colors of your frog's back. Now describe them. Student records color.

What is the color of the underside of the frog? Student records observation.

How would the different colors help the frog hide? Its back blends with surroundings when viewed from above. Underside blends with surroundings when frog is in the water and viewed from below.

Turn your test jar very slowly clockwise. (Remember not to touch the control jar.) How does the frog respond? Usually frog will shift as the jar turns so that it is facing its original direction.

Now turn the test jar very slowly in the opposite direction. How does the frog respond? Same as it did before.

using the book, following directions, picking up equipment for experiments and clearing up before the end of the period.

It is too soon to expect much improvement in writing skills. Don't lose sight of the fact that it is difficult for most of us to express in words exactly what we are thinking. A student may have understanding without being able to put his thought in writing. Or he may fall into a pattern of copying answers without really understanding his results. By checking the groups as they work you can help them understand.

A bog terrarium that combines water and mud and rock is a good place to keep one or two frogs in the classroom. Tadpoles can be kept in a fish tank.

With this lesson the stress is on inborn behavior. Each group will test a frog and describe its responses. Students should learn to handle a frog carefully.

Frogs may have to be ordered from a supply house. If so, allow enough time for delivery. When frogs arrive at school, they can be kept in about two inches of water in battery jars, a sink, or a fish tank. Keep a sturdy wire cover over the frogs and change the water every two or three days. Change it at once if a frog in a group dies. A fountain-like arrangement with continuous running water is ideal.

If it is necessary to hold the frogs for a couple of weeks, put the jars in the refrigerator and they will need no attention.

How would this response help the frog? Let students make suggestions.

Look at the frog in the control jar. Compare its behavior to the test frog's behavior. Students will record their observations.

2. Part Two Three Responses

You are going to test your frog and describe its responses. Place the eraser end of a pencil just above one of the frog's eyes. Remember this is a living animal, and press very gently.

If you wish you can hold the frog carefully in your hand while you do this test.

Can you see an extra eyelid? Yes.

How is it different from your eyelids? It is transparent. The eyelid moves from bottom of eye to top of eye.

When would the frog be likely to use this eyelid? When underwater.

Wait until the frog in the jar is in a resting position. Then put a small piece of paper soaked in vinegar on its back. Do this carefully so the paper does not slip off into the water.

How does the frog respond? Usually it will kick the paper off with a back leg.

In some cities, it is possible to get free frogs from a laboratory that has already used them for pregnancy tests. In this case, the frogs will all be males. There is no guarantee of numbers that will be available from a laboratory of this kind. Make your arrangements with them ahead of time.

About a half hour before the class starts, prepare the cold frogs by adding 12 to 15 ice cubes to their water, and be sure that the water does not warm up during the period. Set up a tray as follows for each group.

1. Part One The frog that is in deep water will usually float but it may sit on the bottom of the jar. Watch it and it will come to the top. Some explanation may be needed for the term clockwise used in procedure 8.

2. Part Two Don't let the vinegar-soaked paper drop into the water. The vinegar is then too dilute to cause a reaction.

Feeding the frog may be a problem if it is in a small jar. Try feeding in a tank or large container with no water in it. Or if you have a frog in a terrarium, use it for the feeding exercise.

Frogs are attracted to movement. They will not eat a dead worm or insect but a piece of meat dangled on a thread will be eaten. Caution the students to be quiet and not move while feeding the frogs.

How would this response help the frog? It rids itself of an irritation.

Wash the frog with water. Now place a small piece of paper soaked in water on the back of the frog.

How does the frog respond? Usually no response.

H 21

What did you prove by doing the water test? It wasn't the water that caused the irritation, it was the vinegar.

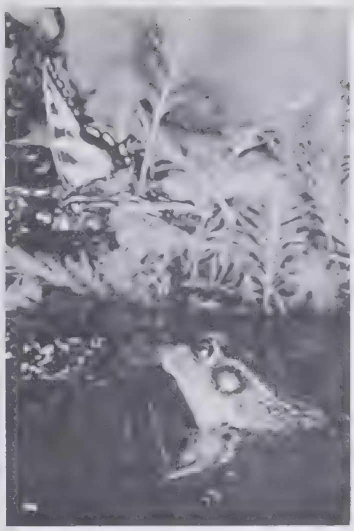
Explain why we call this part of the test a control. It is used as a comparison with the vinegar-soaked paper.

Drop a living earthworm or a mealworm about four inches in front of your frog. Watch carefully for two or three minutes.

How does the frog respond? Student records observations.

What do you think the frog would do if the food was dangled in front of its face? It would probably try to catch and eat it.

Do an experiment to find out whether your guess was right. Explain how you did this experiment. Students record what they did.



3. Part Three Breathing Count

Use a stop watch (or the second hand on a wrist watch) and count the number of times your frog breathes in one minute. Count the movements of the throat.

How many times did your frog breathe in one minute? Record data.

Now take one of the frogs that is in ice water and count the number of times it breathes in one minute. Record data.

Write any difference between the two numbers. Record difference.

How can you explain this difference? The cold slowed down the rate of breathing.

Did the students in the other groups get the same results that your group got? Show the results of the groups by making a chart in this space. Record data.

Why is it better to collect information from other groups rather than to rely on only your own results? Each group can check its results against the others. The larger the sample, the more accurate are the results.

3. Part Three If time runs out, this part may be carried over to the next day. It may be that some groups will get to it and others will not. If the classroom clock has a sweep second hand it can be used instead of a timer or stopwatch. Some students may need help in using the clock to time the frog's rate of respiration.

Check Yourself

1. Did it help you to have the control frog on your desk? Yes. It was used as a comparison.

2. Why did you have water in the jar with the frog? The frog's body must be kept moist or it will die.

3. What effect does cold have on the number of times the frog breathes in a minute? Cold slows down the breathing rate.

4. During what time of the year would you expect the frog's breathing to slow down? Why do you think so? The fall or winter. The temperature drops.

5. How does the frog spend the winter? It hibernates.

6. What does hibernation mean? Spending the winter in an inactive state that is like a deep sleep.

7. Why can hibernating animals get along on just a small amount of food and air? All their body activities slow down.

Hard Cover Follios Preceded by

8. Did the frog learn any of the responses that you saw in this lesson? No. Can you say that these responses are inborn?
The responses are inborn.

9. Why do we call the frog a vertebrate? Frogs have an inside bony skeleton.

Research You Can Do

Describe the changes that happen to the frog's egg as it becomes a frog.

Many other animals live through the winter by hibernating. Read about some others.

1-3. BIRDS! A few lessons cannot tell the many unusual things about them. Like the frog, birds are vertebrates. But they are different from all other animals because their bodies are covered with feathers. Not all birds fly, but feathers and flying go together.

Another unusual feature of birds is the shape of their bones. The front limbs cannot be used for walking or for grabbing. They are used as wings for flying.

Because they can fly, birds have more freedom than most ani-
4. mals and plants. Birds can leave places where there isn't enough food. They can travel to far away places as the seasons change. They can build nests in trees as well as on the ground. (What would you do if you had wings?)

There are many surprising things about feathers. The male bird's feathers are usually brightly colored. But the female's

Reading 8. The Design of Birds

1. Familiarize yourself with all of the Explorations that you are going to do. This will help you stick to the main objectives of each activity and to avoid repetition.
2. Bring out a bird skeleton, if one is available.
3. Ask the students to point out similarities between the frog and the bird. Most of them will see similarities in the skeleton.
4. Encourage the students to contribute to the class discussion. Some of them may have had birds as pets or may know someone who has raised pigeons in a city.

feathers make a dull outfit. That's good for her when she is caring for her young. It helps her to hide. Her colors blend in with the surroundings so enemies can't see her.

→ H 24

If you examine feathers carefully, you will notice that there are different kinds. Each kind does a different job. The feathers on the wings and tail are stiff like the parts of a plane. They are used for flying. The feathers that keep the bird warm are small and fluffy. In cold weather, the bird fluffs up these feathers to trap warm air under them. They grow close to the body, where you can't easily see them. A third kind of feather covers the rest of the body. These give the bird its color and streamlined shape.

Birds take good care of their feathers. They oil them and keep them smooth by using their beaks. At least once a year the feathers **molt** or fall out, a few at a time, and grow in again. Why do you think they don't all fall out at once?

A bird's body must be light in weight and powerful. Its bones are specially built to make this possible. They are hollow and filled with air, but are very strong. The backbone is stiff. Birds

also have a large breastbone that the powerful flying muscles are attached to. These are the muscles that make up the breast meat in a chicken.

No other living things have the sharp eyesight of birds. Their eyeballs are very large for the bird's size and are built for seeing both far away and close up. A sparrow can see small insect eggs near its face and at the same time can watch out for hawks and other enemies. A hawk, soaring high in the air, can see a small mouse in the grass. A bird's eyesight is many times better than a person's.

H 25

The inside of a bird's body is warm, even when the environment is very cold. An animal that has a steady body temperature regardless of the outside temperature is called **warm-blooded**. Birds are warm-blooded, but frogs are not. It takes a lot of energy to keep the body from cooling off. This energy comes from the bird's food, which explains its big appetite. In fact, the need for food explains a lot of the bird's behavior because so much of its time is spent in getting food. When you study bird eggs and baby birds, 5.

5. Remind students that they are warm-blooded. They know that when they are ill, a fever is a sign that something is amiss. They can be reminded that a drop in temperature is dangerous, too.

remember that birds are animals that are warm-blooded and need a lot of food.

Most birds eat insects, rodents (rats, mice, and their relatives), 6. or seeds. What birds eat depends on the shape of their beaks. For example, some birds eat seeds. Their beaks are short and thick because seeds are hard to crack open. Woodpeckers have 7. beaks built to poke under the bark of trees to find insects. Ducks have broad beaks to scoop up food out of the mud.

Feathers, bones, eyes, and beaks are all special structures. They help the birds adapt to their environment. This means that these structures help them to get along in their surroundings.

6. Birds are valuable to people because they destroy insects, rodents, and weed seeds. Many birds—chickens, ducks, turkeys—are sources of food.

7. Make full use of the illustrations as valuable supplementary material.

Exploration 9. Feathers, Bones, Beaks, and Feet

Overview

This Exploration stresses structure and function. Behavior may seem to be secondary until we note that we are talking about feeding, flying, and protection. Complementarity of structure and function are introduced here. This is the first time the students will discuss a warm-blooded animal. This activity adds a new skill and gives the class a chance to make predictions and classify materials.

It is important to have the students read the text material preceding each activity on the birds. This Exploration does not make use of living material, and the class

← H 26

Exploration
9. Feathers, Bones, Beaks, and Feet

1. THE FEATHERS, bones, beaks, and feet of birds are adapted for special jobs. You are going to look at these parts to see how well made they are for the work they do.

2. Part One Feathers

You will be given different kinds of feathers and a hand lens. Look at them carefully and sort them into three groups. Put the feathers used for flying in one pile. Put the feathers that cover the body and give it color in another pile. Put the feathers that keep the bird warm in a third pile.

The stiffest and largest feathers are called **quills.** Quills grow on the wings and tails. They are important in flying. Run your thumb and fingers back and forth over a quill feather until it is very uneven. Now try to smooth it out again. Use your hand lens to discover the small hooks that hold the parts of the feather in place when it is smooth.

What do these hooks look like? You may want to draw a picture to show how some of them look when magnified.

You smoothed out the feather with your fingers. How does the bird smooth out its feathers? Birds use their beaks.

will benefit from a discussion based on the text and the illustrations. The illustrations were chosen with great care to take the place of any materials that you may not have access to.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) describe three different kinds of feather.

(2) explain how birds' bones are built to help them fly.

(3) give one or more examples of the structural adaptations of birds' beaks.

(4) give one or more examples of the structural adaptations of birds' feet.

Materials for Each Group

feathers (quill, contour, downy)
hand lens (at least one for each group, more if available)
chicken leg or wing bones (at least one for each group)
hammer
Optional
bird skeleton
bird specimens or charts
living bird

Time

Three days

1. The bird is an excellent animal to illustrate the complementarity of structure and function. If you can, borrow

Use your hand lens and look at a few of the **downy feathers.** These are the ones that grow close to the skin and keep birds warm. Describe how a downy feather looks. **Student description.**

Look at a **contour feather** with your hand lens. These are the feathers that cover the bird's body and give it much of its color and smooth shape. What does a contour feather look like? **Student description.**

3. **Part Two Bones**

You have been given a wing bone or a leg bone to look at and experiment with.

What kind of bird did your bone belong to? **Chicken (probably).**

Bend the bone with your hands. How strong is it? **It is hard to break.**

Place the bone on a pad and crush it with a hammer. Describe what the crushed bone looks like. **Hollow inside. Outside thin and splinters.**

How are bird's bones especially suited for flying? **They are air-filled, thus light in weight and very strong.**

a parakeet or other bird for a few days. Feathers can be ordered from a supply house or collected from a chicken market. If you go to a market, ask for chicken or duck feet. They will be interesting additions to this lab lesson.

You can ask the students to bring chicken bones to school, but you must allow about a week to collect them. It is a good idea to clean them off with Clorox before using them. A better idea is to buy chicken legs or wings and cook them to make it easier to remove the flesh.

2. Part One While the students sort the feathers into three groups, walk around and question their decisions.

3. Part Two Ask the students if they recognize the part of the animal that the bone came from. "Why do you think so?" If possible, have a few chop bones that are comparable in size to the chicken bones and compare weight. Another animal's leg bone, like a ham or lamb bone can be used for comparison. Give a strong boy or girl a chicken bone and ask him or her to break it.

4. Part Three Here again, resist the temptation to tell the answers. If specimens are available, use them along with the pictures. If you have chicken feet, use them as examples of scratching feet.

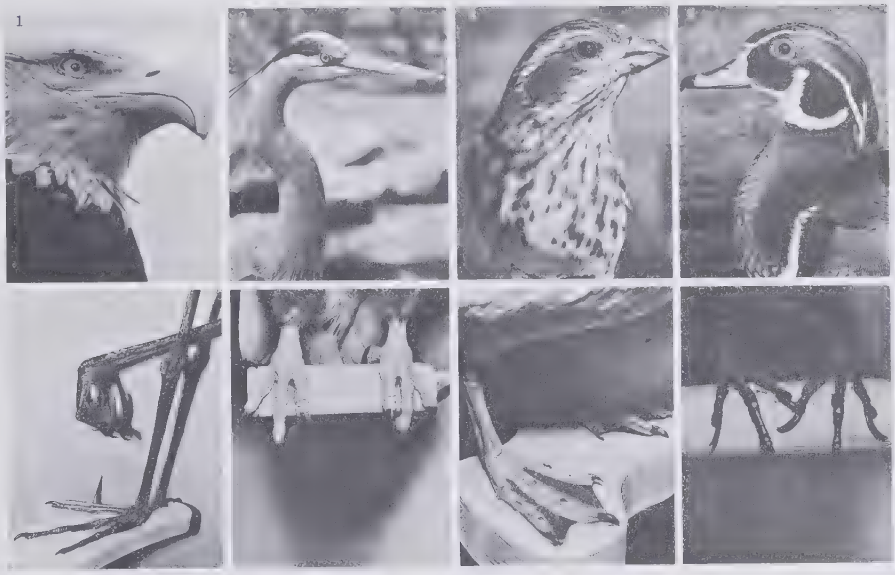
← H 27

4. Part Three Beaks and Feet

Birds don't have teeth or front paws. So they must depend on their beaks and feet for getting, holding, crushing, or tearing food. If you look carefully at the beak and feet of a bird, you can usually tell what kind of food it eats.

Look at the feet and beaks of the birds shown here. Draw lines to connect the beaks and feet that you think go together. Then fill in the chart. Remember that birds eat seeds, fruits, nuts, insects, worms, fish, and small animals. Some birds suck up juices from plants.

Hard cover users: To reproduce the bird pictures for this Exploration please turn to page T 55 or direct students to the Laboratory Supplement.



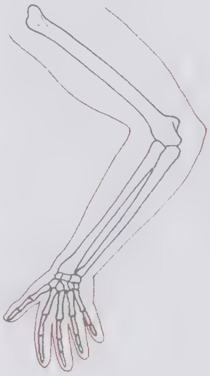
Answers will vary. The following are examples.

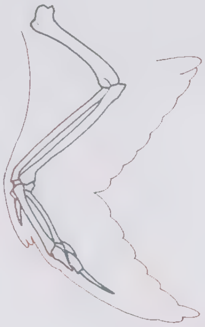
	What it probably eats	The jobs its feet probably do
Bird 1	Small animals.	Tearing.
Bird 2	Fish. Or it sucks up juices from plants.	Wading.
Bird 3	Nuts, seeds.	Getting food.
Bird 4	Sucks up juices from plants.	Swimming.

Check Yourself

1. How does the structure of a feather help it work? Feathers are light in weight, which helps flight. Some are stiff also a help. Some are soft and keep body warm. Some are colored and serve to camouflage.

2. How does the structure of its bones help a bird fly? Bones are hollow which makes for strength with light weight. They support body and keep it light.





3. Birds' feet are specially designed to do different jobs. Can you give some examples? Webbed feet for swimming, toes for perching, sharp claws for catching prey, long toes for wading, scratching or walking.

4. Beaks are specially designed to do different jobs. Can you give some examples? Sharp and curved beaks for catching prey, short and strong for cracking seeds, long and tubelike for sipping nectar, long and flat for catching fish, spearlike for catching fish, straight and hard for hammering wood.

5. Explain how the wings of a bird are like a person's arms. They are the front limbs and are attached to the same area of the skeleton.

6. How are arms and wings different? They have different functions.

7. Name two other animals whose front limbs are like arms. Explain why you think so. Fish, whale, seal, dolphin, frog. They are attached to the same area of the skeleton.

8. Name two animals besides birds that can fly. Bats, insects, "flying" squirrels.

9. What is one advantage of molting in the late summer? The new feathers make it easier for the birds to migrate, because the old damaged feathers are shed.

Research You Can Do

The penguin is a bird that cannot fly. How is it adapted to life in the Antarctic?

The bat is a flying animal, but it is not a bird. How are the wings of a bat different from the wings of a bird?

The ostrich is a bird that cannot fly. How is it adapted to life in Africa? ____________________

____

____

____

____

A book you would enjoy looking at is *The Birds* by Roger T. Peterson. It's in the *Life Nature Series.*

As WINTER COMES, the earthworm tunnels deeper into the ground. The frog hibernates. Some birds migrate. These are all examples of inborn behavior.

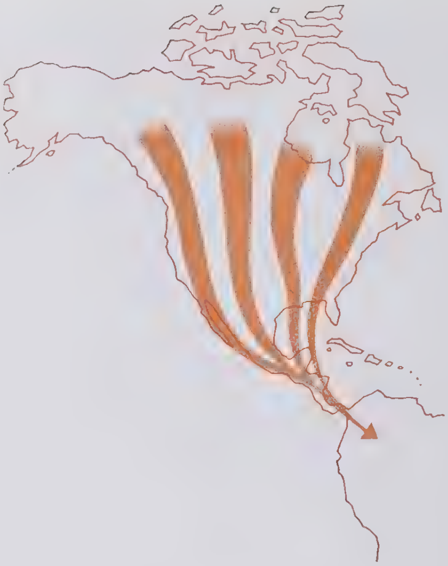
Animals **migrate** (*MY grayt*) by moving back and forth between two distant places. They migrate to escape cold weather or to find more food. Sometimes animals migrate to find a good place to reproduce. Salmon, eels, seals, and other animals migrate. But the travels of birds have been studied more than the rest.

Many birds migrate by flying from the north to the south in the fall. In the spring, they fly north again. Some birds migrate by moving from the top of a mountain to the valley at the bottom and back again. Some birds travel thousands of miles. The Arctic tern

Reading 10. Flying Puzzles

1. No one really knows why birds fly into lighted buildings. Let the students speculate. This is a good place to point out that we do not know all the answers.

2. Watch the newspapers for news of migrating birds. You can keep a bulletin board with a section on birds.



→

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goes from the Arctic near the North Pole to the Antarctic near the South Pole. That's 10,000 miles!

Some birds do not migrate at all. Cardinals, pigeons, and woodpeckers are examples.

There are four main routes that birds in North America follow when they fly south. Look at the map to see where these routes are. They are called **flyways.** Which flyway would be the easiest for birds in your state to use?

The migration of birds is a puzzle. There are still many questions about it. We wonder, for example, how they know the right time to fly south. Is the stimulus cold weather, or shorter days, or less food? (There are not as many insects, berries, seeds, and fruits as the weather gets cold.)

The biggest question is how the birds find their way. All of the birds of one kind follow the same route and stop in the same area. They may return by a different route. But they end up back where they started. Young birds that have never taken part in a migration can find their way alone. Even if they must go hundreds of miles!

People have suggested explanations. One theory is that birds steer by the positions of the sun and the stars. Another theory is that something inside the bird's body steers the bird in the right direction. In fact, no one completely understands the migration of birds.

Migrating is dangerous. Birds lose their way because of fog or
1. high winds. Storms, tall buildings, and television towers kill millions of birds each fall. At night, migrating birds crash into brightly lit buildings. That is hard to explain. Can you think of a reason why it happens? The owners of tall buildings will sometimes turn off the lights during the migrating season.

You might wonder how we get information about migration.
2. Flocks of migrating birds are tracked by radar. Also, people who are interested in birds watch for the birds each year. Even in a big city you can watch for migrating birds and keep a record of what you see. Sometimes the birds stop in city parks to rest or to feed.

To keep track of birds, people sometimes put small metal bands around the birds' legs before they migrate. This is one way to find out where birds go when they fly north or south. To do this you must catch the bird without hurting it, band it, and then let it fly

away. The bird may be found later, dead or alive. The band asks the finder to send information to the researcher.

Have you ever found a banded bird? Watch for them! This is one way you can help in an important work.

3. By knowing about the migration of animals like salmon and seals, people have been able to catch them or save them from destruction.

Exploration 11. Birds Don't Need Maps

Overview

In this Exploration a more complicated type of inborn behavior is introduced. It is tied in with knowledge gained in previous activities. Although migration is not understood completely, we do look to the environment for the stimulus that triggers this complex reaction. Most classes will need a bit of geography lesson before they are able to use the map. A chance to hypothesize and a chance to appreciate the mysteries of migration are built into this pencil laboratory lesson.

Exploration

11. Birds Don't Need Maps

Alaskan ruddy turnstone

Golden plover

Sanderling

Bobolink

1. IN THIS LESSON you will map the migration routes of four birds.
You may not know these birds, but they are some of the cham-
2. pion long-distance fliers. The migration path of the Arctic tern
has already been drawn on the map on the next page. Complete
3. the map by showing the routes that the other birds take when
they migrate.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) give one or more reasons why birds migrate.

(2) draw one or more migratory routes on a map.

Materials for Each Group

colored pencils (red, green, blue)

Time

Two days

1. This Exploration is meant to give an appreciation of the distance that birds travel when they migrate. However, *do not* expect students to memorize the routes. Although these birds are not familiar to the students, they were chosen because of their dramatic routes. It is necessary to help students read the map before they start this lesson.

2. This activity is done individually rather than in groups and provides experience in following directions.

3. We are still studying inborn behavior and migration is a complicated one.

4. The **Alaskan ruddy turnstone** flies each autumn from Alaska to Hawaii. Use a red pencil to show this route. Put the bird's name on the red line.

The **golden plover** flies from northern Canada to southern South America, a distance of 8,000 miles. Use a blue pencil to show this route. Mark it with the bird's name.

5. The **sanderling** is often seen on warm sandy beaches, but it breeds in the Arctic. Some of them migrate from Greenland across the water to England or the New Jersey shore. Others live in Alaska and migrate to Japan and Hawaii. Draw at least one of these routes in green pencil.

Many **bobolinks** breed in Canada and migrate to the southern part of South America. They fly over Cuba as they make this trip. Use your black pencil to draw this route on the map.

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Check Yourself

1. Can you suggest three reasons why birds migrate? Possibly lack of food, change of weather, change in the length of the day or in the relative position of the sun.

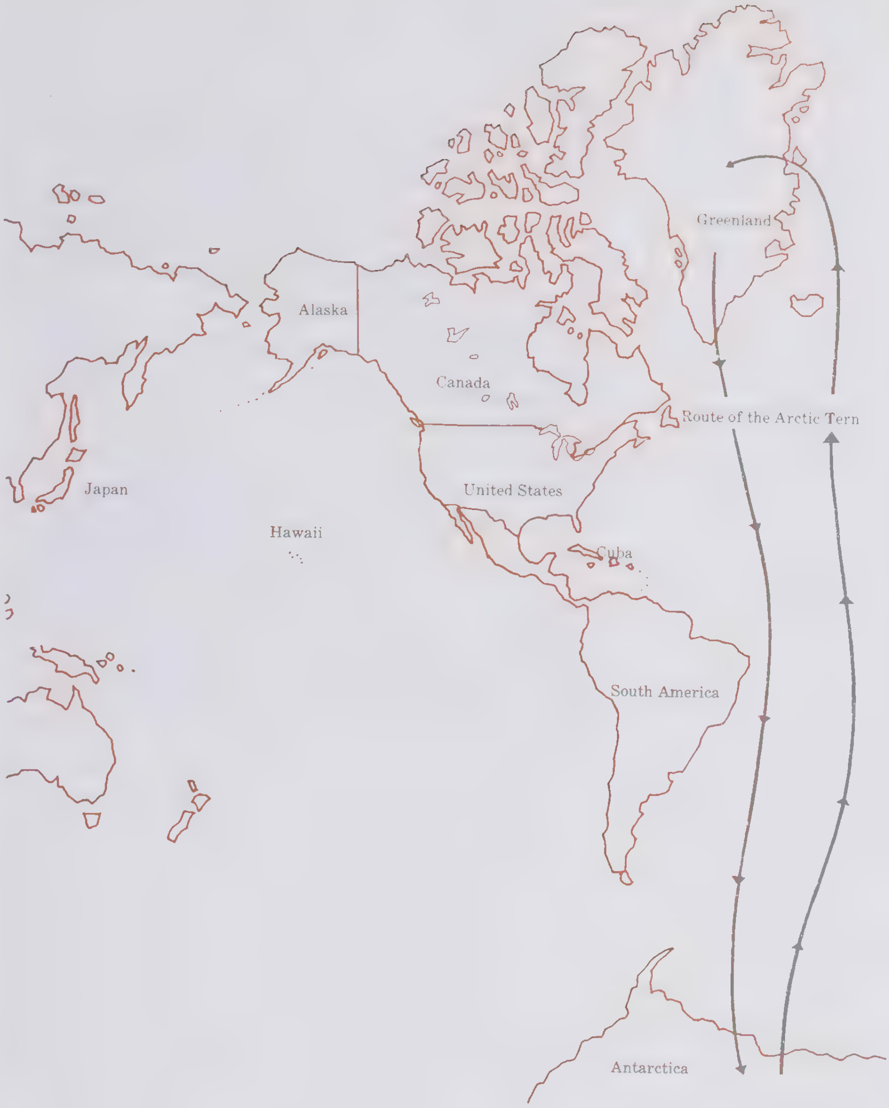
2. How do birds know when to leave for their trip south? Inborn behavior, possibly stimulated by change in length of day or in temperature.

3. How do we know that each kind of bird always follows the same route? Through observation and banding.

4. Why don't birds that fly at night get lost? They are possibly guided by the stars.

4. You will find that most students enjoy using the colored pencils. City youngsters see sparrows around all winter. Build on what they know by reminding them that not all birds migrate. A few students may recognize robins and know that they return north in the spring; but they may never have considered their return as migration. Get the class to try to tell you when the first robin may be seen in their area in the spring.

5. If you don't need time to teach geography, the class may complete this lesson in less than 40 minutes. The rest of the period can then be used to answer questions. A large globe that can be marked with chalk to show the migratory routes will add to this lesson. The Arctic tern's route is especially impressive.



Hard cover users: To reproduce the bird migration map for this Exploration please turn to T 56 or direct students to the Laboratory Supplement.

5. How do tall buildings like the Empire State Building affect migrating birds? Lights on tall buildings seem to attract birds and cause death by collision.

6. Name one bird that can make a single flight over thousands of miles of ocean. Arctic tern, golden plover, Alaskan ruddy turnstone, bobolinks, sanderlings.

7. Why do you think many birds return north in the spring?
Let student support reasons. The return is possibly related to nest-building and reproductive behavior.

8. Why do we call bird migration a type of inborn behavior?
It is not learned.

IN THE SPRING, migrating birds return from their winter homes.
1. Stay-at-home birds just stay at home. But they all mate and build nests. Then the females lay eggs.

Each kind of bird builds its own kind of nest. The parents gather their materials with their beaks. Some nests, like the robin's, are placed in the forks of branches. Hummingbirds place their nests on single branches. Weaver birds build nests that hang like swings from a tree. Barn owls nest in barns or hollow trees, and burrowing owls nest in holes in the ground. Some water birds build floating nests.

Emperor penguins don't build any nest at all. The female lays one egg, and the male holds it on top of his feet until it hatches.

If there are nests in the classroom, spend a few minutes studying one of them.

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Reading 12. Nests are for Eggs

1. Available birds' nests should be distributed throughout the room, or pictures in the text can be used to answer the questions.

List all of the materials that you can see in the nest. Answers vary.

How does the bird know how to make a nest? Inborn behavior.

An elf owl's nest

A robin's nest

A weaver bird's nest

A grebe's nest

A nest can be plain or fancy, neat or sloppy. But it is almost always built close to food. Nests give the young birds some pro- 2. tection from enemies and from bad weather. Nests are not homes for the parents.

The parents sit on the eggs to keep them warm so they will be sure to hatch. This warming is called **incubation** (*ihn kyoo BAY shuhn*). At hatching time, an inborn response makes the baby bird

2. Continue to stress inborn behavior. Students will think that the female cowbird is a bad mother and that the "foster mother" of a young cowbird is a stupid bird! Here is a chance to point out the mechanical nature of inborn behavior. The sequence of topics in this lesson is nest to egg to young bird.

3. Since this is the last lesson on birds, this is a good time to point out the importance of birds to us. Students have learned that birds eat weed seeds, insects, and rodents; and you might emphasize how this is helpful to man. City students may not think of chickens and turkeys as birds, so make a point of reminding them of the importance of poultry as food.

Reminder: Order snails and Elodea for Chapter Three.

Can you tell which young bird is a cowbird?

break open the eggshell. It's hard work. The baby has a hard tip on its beak to help it, but getting free is tough. When the bird finally breaks out of its shell, it is wet, weak, and tired.

Cowbirds don't build nests of their own. The females lay their eggs in other birds' nests. Then they fly away. When the eggs hatch, the young cowbirds are cared for and fed by the foster mother. She automatically feeds any open beak in the nest. An open beak is a stimulus she must respond to. So she feeds the hungry cowbirds right along with her own young. Some cuckoos behave the same way.

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The young cowbird may even push all the rightful owners out of the nest. The pushing is an inborn response that helps the cowbird survive. It is not a planned action. Maybe you can tell why only one cowbird egg is placed in each foster nest.

Birds take good care of their young. They feed them, fight for
3. them, and build nests to shelter them. When the time comes, the parents help the young leave the nest.

Birds can afford to lay only a few eggs, because many of the baby birds survive. Frogs lay hundreds of eggs. When there is a good chance their young will grow up, animals have few babies. When there is little chance for survival, they produce hundreds or thousands of young.

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Which do you think has a better chance of survival, a young frog or a young bird? ________ A young cat or a young person? A young bird and a young person.

Check Yourself

1. How do we know that nest building is an inborn response?
It doesn't have to be learned. All birds of a kind build the same type of nest.

2. Some birds learn to live in birdhouses. Would you say that these birds are changing their inborn behavior? ________
Yes, unless birdhouse resembles nesting area.

3. In what ways are birds helpful to man? They are used for food and feathers. They eat rodents, insects, and seeds of weeds.

4. How can people that live in a big city help to protect birds?
People can put out food for them in winter. They can observe migratory flights and band the birds. They can restrict insecticides. They can vote for conservation measures and protect birds from mischief and vandals.

Research You Can Do

What is the National Audubon Society? ________

How do oil spills in the ocean affect birds?

How can oil damage be lessened?

Most farmers use chemicals to kill insects that eat their crops. What do these chemicals do to birds?

What do you think should be done about this problem with poisonous chemicals? ______________________________

____

____

____

This game is played like *Jeopardy*. You might have seen it on television.

The Answer Box below gives you answers, and you have to think of questions to match them. In this game the answers are divided into five groups, Insect, Earthworm, Frog, Bird, and General. Be sure that the questions you write fit the right group. Each question is worth 10, 20, 30, 40, or 50 points.

ANSWER BOX

Points	Insect	Earthworm	Frog	Bird	General
10	*six*	*tunnel in the ground*	*tadpole*	*feathers*	*stimulus*
20	*light*	*dampness*	*hundreds*	*migration*	*response*
30	*cover garbage cans*	*through its skin*	*in the mud*	*by the stars*	*environment*
40	*social*	*fertilize the soil*	*color of the skin*	*light and strong*	*vertebrate*
50	*lays eggs in water*	*bristles*	*breathe slower*	*warm-blooded*	*control*

Follow the example in the Question Box. Write as many questions as you can. Then add up the number of points you earned. You might want to compare your questions with the ones written by the rest of the class. Do you think there will be only one right question for each answer?

QUESTION BOX

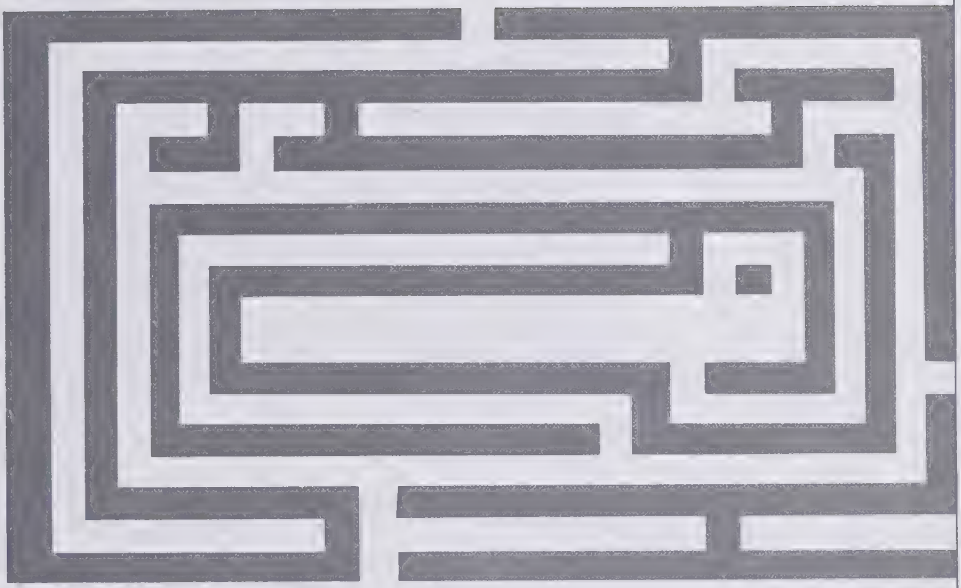
Points	Group	Answer	Question that matches the answer
10	*Frog*	*Tadpole*	*What is a baby frog called?*
	Earthworm	Tunnel in the ground	Where does the earthworm live?
			This is an example. Questions will vary

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 28 or direct students to the Laboratory Supplement.

Points	Group	Answer	Question that matches the answer
		Answers will vary.	

2 Human Behavior

← H 39



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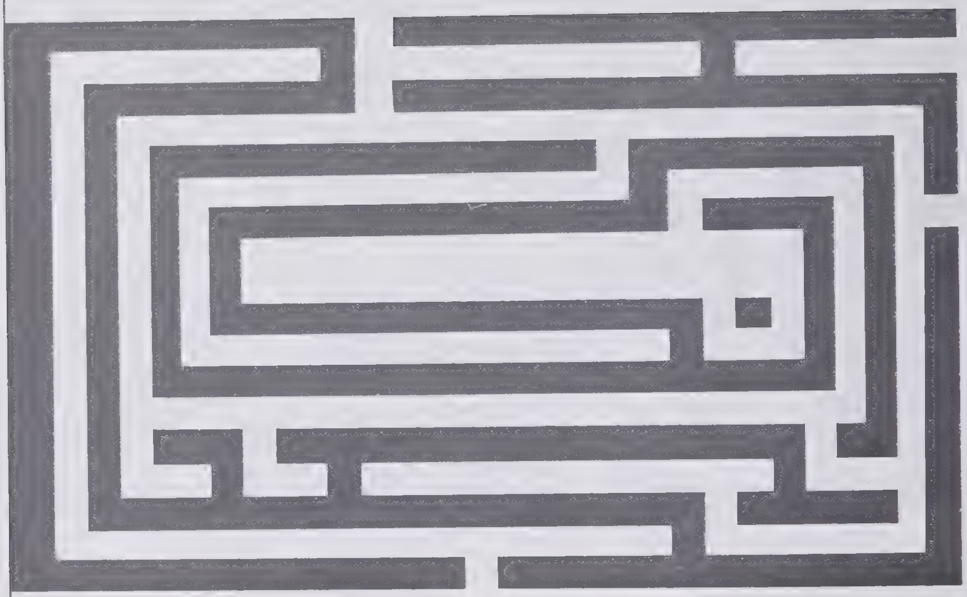


Hard Cover Folios Preceded by H

1. *Homo sapiens* — The Thinking Human

1. PEOPLE are probably the most interesting animals on Earth. We
can live any place we want — in cold regions or deserts, in caves
or skyscrapers. Because of the way our bodies are put together,
we can walk and run and swim and dance and leap into the air.
Because of the way the bones of our hands are put together,
we can use tools. For instance, we can use forks or chopsticks to
2-3. eat with. We use shovels to dig with, and saws and hammers to
build with. What other tools can you think of?

Reading 1. Homo sapiens—The Thinking Human

1. The title of this Reading may need some explanation. The students may be aware that plants and animals have Latin names but *homo* may have other connotations.
2. Stress the importance of the human thumb. Ask what activities would be difficult without a thumb.

4-5. In all the world there is nothing quite like the human brain. By using our brains, we have built cities, invented science, and written poetry and music. We have also learned ways to talk to each other. In fact, the most important human invention may be languages. Can you think of any reasons why?

Thinking about questions and trying to solve problems is called reasoning. Of all animals, we can do that best, because of our special brain.

In the next few lessons, you will be investigating people. You will learn the ways in which your behavior is like that of other animals and the ways your behavior is unique. You may reason 6. that we are well described by the term *Homo sapiens* (*HOH moh SAY pee ehnz* — the thinking human.

The words you are reading now were set into type on a machine like this one. Do you think this machine is more complicated than the sculptor's hands you just saw?

3. Make use of the illustrations in this lesson and point out that a tool is an extension of part of the body. Ask students if they can name animals that use tools.

4. The brain will be studied later as part of the nervous system. Use the illustration to point out how the nervous system of humans differs from that of the other animals studied so far. Students will be able to see similarities, too.

5. As we will see in the next few activities, humans are born with some inborn reactions, but most of what they do is learned.

6. The term "unique" may give students some problems because it is unfamiliar. Have the students list ways that they are unique. How many of these ways are due to a special brain? "Unique" means being without a like or unlike anything else.

Exploration 2. Your Inborn Responses

Overview

This activity lays the groundwork for some understanding of human behavior. The class knows about inborn behavior from its experience with insects, earthworms, frogs, and birds and should have no trouble recognizing this kind of behavior in themselves. The responses in this lesson are simple and some of them will be familiar to students.

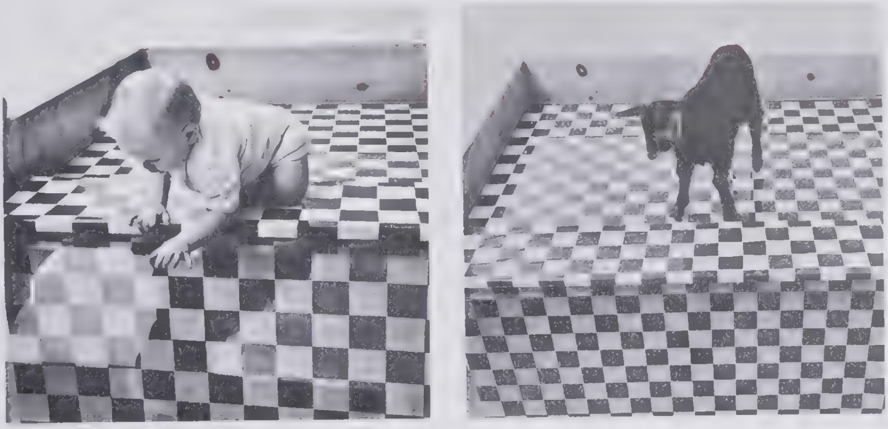
Behavioral Objectives

After completing this Exploration, the students will be able to

(1) identify inborn (reflex) responses in human beings.

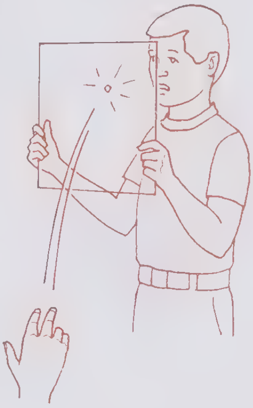
(2) differentiate between learned and inborn responses in human beings.

Exploration
2. Your Inborn Responses



In this experiment the baby and the kid see a cliff in front of them. The kid's inborn response is to back away. The baby hasn't learned to avoid cliffs yet. A glass shelf saves him from falling.

You have seen inborn responses in insects, earthworms, frogs, and birds. Do you have any inborn responses yourself? You can try the following tests to find out.



1. Part One Control Yourself!

Have one person hold a clear piece of plastic in front of his or her face. Then throw a wad of paper or a ping pong ball at the plastic. Try this three or four times. (If you use glass instead of plastic, be careful not to break it.)

What behavior did you notice? **Usually the eyes will blink.**

Materials for Each Group

piece of clear plastic or glass, at least 8″ × 11″
sheet of scrap paper
flashlight or small lamp

Time

Two days

The students work in groups and each group does all parts of the lesson.

1. Part One If glass is used instead of plastic, make sure the sharp edges are taped.

Is this learned or inborn behavior? Inborn.

Can the person behind the plastic control his behavior? Usually not.

Could this response be useful? Yes. It protects the eyes.

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2. Part Two The Knee Jerk

Have one student sit with his or her knees crossed. Have another student tap the first one just below the kneecap with the side of the hand. Try this three or four times.

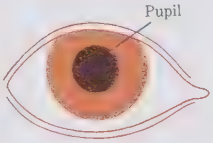
What behavior did you notice? The leg jerks up (if the right spot is hit).

Is this learned or inborn behavior? Inborn.

Can this behavior be controlled? Yes, by consciously deciding to control it.

Why would a doctor test this response? As part of a test to see if the nerves are reacting normally.

3. Part Three Changing Pupils



Do this part with one other person. Look into your partner's eyes. Notice the size of the pupils. (The pupils are the black areas in the center of the eye. They are openings that let light into the eye.) Now shine a light into your partner's eyes.

What happened to the size of the pupils? They get smaller.

2. Part Two Ask students if they would get the same response if they tapped the kneecap of the other leg.
3. Part Three A small lamp can be used but should not be too bright.

What stimulus caused this change? Light.

Is this behavior learned or inborn? Inborn.

What other stimuli might cause this change? Let students speculate.

A pleasurable sight may cause the opposite reaction.

Now have your partner close just one eye for two or three minutes. When he or she opens it, quickly observe the size of the pupil.

What change do you see in the size of the pupil? Is it bigger or smaller than the pupil of the eye that was open? Answers vary.

How do you account for the difference in size? Let students speculate.

Check Yourself

1. Fill in your responses to the following stimuli. Also fill in the responses you think a baby would have.

Stimulus	Your Response	Baby's Response
a hot object touching you	Pull away.	Pull away, cry.
a loud bang nearby	Jump.	Jump, cry.
pepper sprinkled in the room	Sneeze.	Sneeze.
eating ice cream	Pleasant taste, flow of saliva.	Flow of saliva, pleasant taste, may react to cold.
a boring game	Yawn, feel tired.	Yawn, feel tired, may cry.
a bright light shining in your face	Blink.	Blink.

2. What kinds of behavior were you comparing in the chart you completed? **Inborn. Eating ice cream and playing a boring game may involve learning.**

3. What other information does this chart give you? **A baby's inborn responses are like ours. Different parts of the body can respond without learning.**

4. Name at least three more inborn responses. **Knee jerk, sucking, grasping, coughing, fear of falling, blushing, sweating, shivering.**

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5. Are there any inborn responses that can be controlled? **A few, if the thinking part of the brain is used. Examples are knee jerk, coughing, and blinking.**

6. What are some stimuli in your environment that cause inborn responses? **Cold, heat, loud sounds, sharp objects, food, light, pollen, dust, darkness, seeing someone else yawn.**

Exploration 3. Conditioned Behavior

Overview

We move now to behavior that includes learning. It is important to point out that much of human behavior is learned and that some of it is the result of conditioning. At times the class will understand conditioning in animals better than in themselves.

There are two generally recognized forms of conditioned learning: classical (Pavlovian) conditioning and operant conditioning. In Pavlovian conditioning the subject of an experiment is made to respond to one stimulus as though it were another. For example, Pavlov trained dogs to salivate when he rang a bell, just as they did when he showed them a bowl of food.

In operant conditioning the subject learns to behave in a certain way because it is rewarded or punished for its responses. As an example, a laboratory rat may accidentally push a lever on a machine and release food into the cage. This may occur several times as the rat explores the cage, but the animal soon learns to push the lever when it wants food. It learns to operate on its environment—therefore the term operant conditioning. This Exploration is based on the principles of Pavlovian conditioning.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) identify conditioned reflexes in human beings.
(2) explain that conditioned behavior is learned behavior.
(3) identify original and substitute stimuli in examples of conditioned behavior.

Exploration
3. Conditioned Behavior

1-3. For this experiment you should take out a pencil and paper and follow the teacher's instructions. When the class is finished, answer the following questions:

What unusual response (if any) did you notice? Usually some

4. students will continue to write after teacher stops giving the command.

5. Why do you think some people responded the way they did?

Let students speculate. (They associate the command with the tap.)

Did everyone respond the same way? Usually, no.

Is this change in response a lasting one? How could you find out?

No, as you find by trying the same test another time.

Check Yourself

6. 1. What stimuli usually make you write? You are asked to write.

You want to write.

2. What stimulus made some people write in this lesson?

Tapping on the desk.

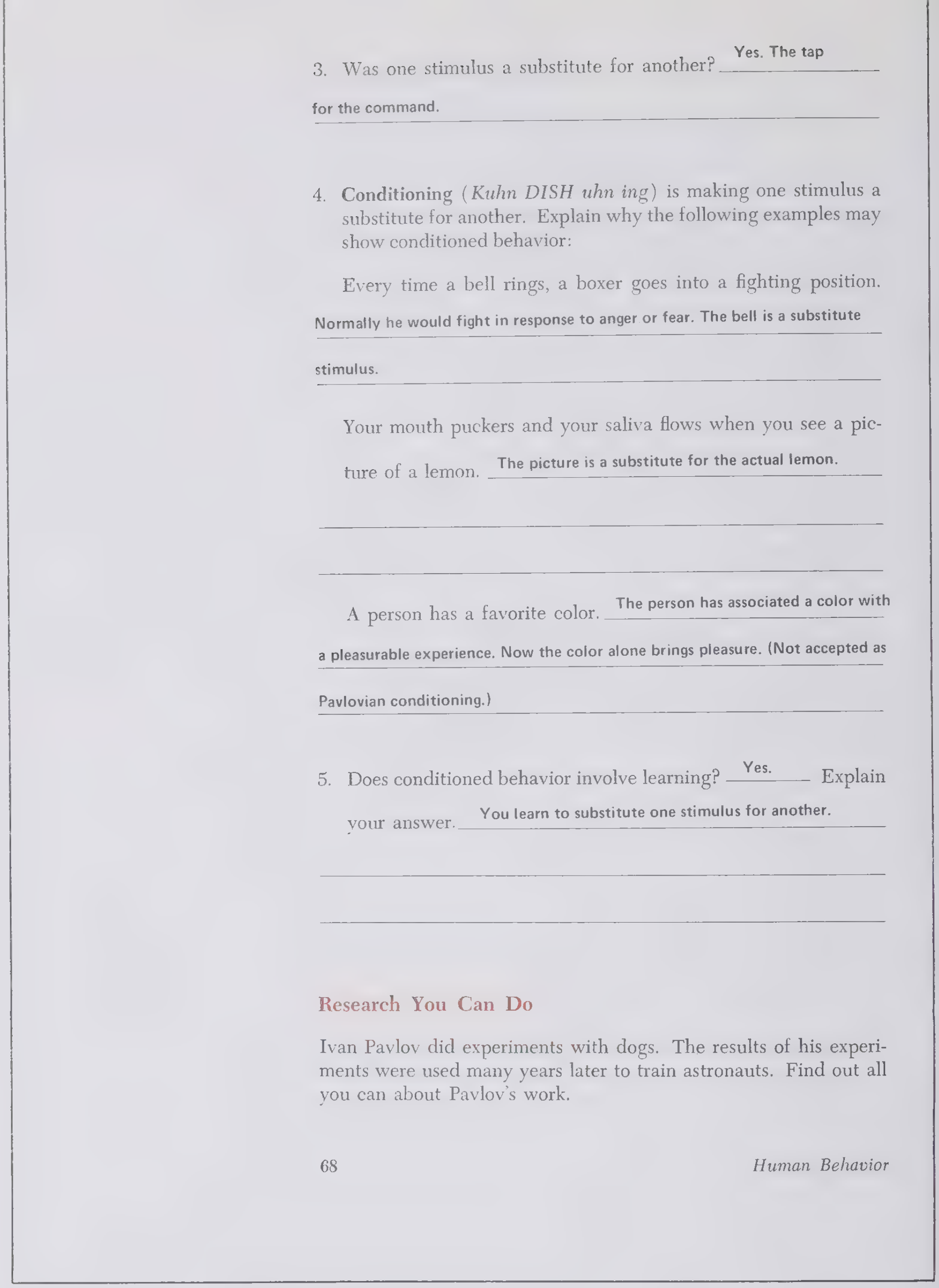
Materials for Each Group

lead pencils
paper

Time

Two days

1. Have the students take out a pencil and piece of paper.
2. Tell them to write a certain word at the command "write." This word might be biology or behavior or the name of your school or town.
3. A split second before you give the command "write," tap the desk firmly with a ruler.
4. Do this (tap, then say "write") about fifteen times. Then, without breaking the rhythm, just tap without giving the command.
5. Continue to tap without giving the command as long as a few people are responding. *Do not* continue until only one is responding. Avoid embarrassing any one student.
6. Practice this before you meet the class.
7. The rhythm of tap-command is important to keep up. The whole lesson should be treated in a serious way to insure success.



3. Was one stimulus a substitute for another? Yes. The tap for the command.

4. **Conditioning** (*Kuhn DISH uhn ing*) is making one stimulus a substitute for another. Explain why the following examples may show conditioned behavior:

Every time a bell rings, a boxer goes into a fighting position. Normally he would fight in response to anger or fear. The bell is a substitute stimulus.

Your mouth puckers and your saliva flows when you see a picture of a lemon. The picture is a substitute for the actual lemon.

A person has a favorite color. The person has associated a color with a pleasurable experience. Now the color alone brings pleasure. (Not accepted as Pavlovian conditioning.)

5. Does conditioned behavior involve learning? Yes. Explain your answer. You learn to substitute one stimulus for another.

Research You Can Do

Ivan Pavlov did experiments with dogs. The results of his experiments were used many years later to train astronauts. Find out all you can about Pavlov's work.

Exploration 4. How You Form Habits

Overview

It will surprise most students to learn that habits like biting the fingernails, smoking, and punctuality are learned. Once this realization is there, students find it easy to understand the mechanics of habit formation. Patterns for making good habits and breaking bad habits should be discussed.

Try to get a student to point out why the class is divided into two groups for this lesson. Most students will discuss habits, good and bad, quite openly. They know the problems involved in breaking some habits and realize the seriousness of physical and psychological dependency on drugs, alcohol, and tobacco.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) classify habituation as learned behavior.
(2) describe habit formation as the constant repetition of a behavior.
(3) give examples of habits.

Materials for Each Group

pencils
paper
stopwatches or clocks with second hands

Time

Two days

Exploration
4. How You Form Habits

Once you get in the habit, it's easy.

1. HABITS have to be learned. Then, after a while, you don't have to think about them. Habits make up a large part of your behavior.

Today you will study one habit. It will help you understand 2. others. The class will be divided into two groups. Each group will have a timekeeper.

Group 1 Cats and Mice

3.

Take out a piece of paper and copy the paragraph in the box on the next page. The timekeeper will write down how long it takes.

Now turn the paper over. Copy the same paragraph again. This time DO NOT dot the i's. DO NOT cross the t's. DO NOT copy any capital letters. Write small ones instead. The timekeeper will write down how long it takes you.

1. Divide the class into two groups.
2. Each will do the whole lesson, but in a different order. In this way, each group acts as a control for the other. Try to get someone in the class to realize this.
3. It is important for the students to turn over the paper before writing the paragraph a second time. Otherwise they tend to copy the second paragraph from their paper instead of the book. This adds a variable.

Group 2 Mice and Cats

4.

Copy out the paragraph in the box below. As you write, DO NOT dot the i's. DO NOT cross the t's. DO NOT copy any capital letters. Instead of the capital letter, write a small one. The timekeeper will record how long it takes you to copy the paragraph.

> The true story is told of an island on which there lived millions of mice. The mice just about took over the place. On the island a plant grew that scientists wanted to use in making important medicine. To save the plants and to get rid of the mice, cats were brought in to fight the mice. The cats did their job too well. When all the mice were killed, the cats grew so wild and fierce that the men had to move out. This left the whole island to the wild cats.

Now turn your paper over. Copy the same paragraph again, just as it is printed. The timekeeper will write down how long it takes. Both groups should answer these questions:

H 47

Is there any difference in how long it took for each paragraph?

Students record results.

How can you explain any difference? **Usually it takes longer NOT to punctuate properly because writing is a habit.**

Count the number of i's that you *did* dot, even though you were told not to. Count the number of t's that you *did* cross. Count the number of times you wrote capital letters. Write these numbers down:

Dotted i's ______ Crossed t's ______ Capital letters ______

4. Do not be surprised if some students work faster when they are not dotting the i's or crossing t's. Some of them write this way, anyway.

Why did you make these mistakes? We are in the habit of dotting i's and crossing t's and copying carefully.

Check Yourself

Can you think of any eating habits that pets have?

1. How do you think habits are formed? By doing the same things over and over until the action becomes automatic.

2. Why is it so hard to change a habit? Because it is automatic.

3. Is a habit learned or inborn? Learned.

4. Give some examples of how habits save time. They save time because we can do things by habit without thinking and can, in fact, be thinking of something else. Let students give examples.

5. List some good habits that should be formed to help you do the following things:

Studying Have quiet place, good lighting, regular time to study, review lesson.

→ H 48

Is getting to school on time one of your habits? Does playing hockey involve any habits? How about smoking—is it a habit? Even the way you sit can be a habit. Are you a sloucher by habit?

Eating Use utensils, chew carefully, eat neatly, don't talk with mouth full.

Driving a car Signal for a turn, stop at red traffic light (for example).

Getting along with friends Being prompt, considerate, etc.

Getting along with parents Being considerate, listening to advice, and similar.

6. What steps would you take in forming a new habit? Decide what new habit you want to form. Concentrate on doing it over and over. Have friends help you by reminding.

7. What steps would you take in breaking a bad habit? You must decide you want to break it. Concentrate on breaking it. Have friends and family help. Substitute a new habit for old one.

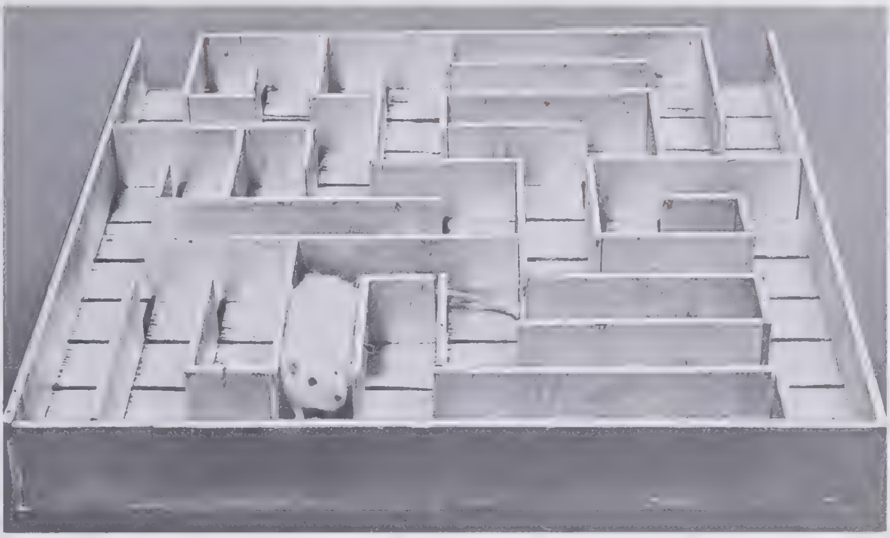
8. What effect do your friends have on the habits you form?
Their activities and interests may influence you to follow suit.

9. List ten bad habits. Tell why you think each one is a bad habit. Let students suggest.

10. List ten good habits you have. Why do you think each one is a good habit? Let students suggest.

← H 49

Exploration
5. Keep on Trying!



Most of the things you know are things you had to learn. No one is born knowing how to talk, or read, or turn on a radio. One way that you learn is by trial and error. You try something and when you make an error, you try again. Very often you keep on trying something until you find an answer. Today's study will help you understand how you learn by trial and error.

Carefully cut out the puzzle on the next page. Work with a partner. Your partner will be the timekeeper, while you put the puzzle together. The object is to make a square out of the four pieces. Then change places. You be the timekeeper while your partner works out the puzzle. Each person should do the puzzle three times. Don't rush your partner!

Write down how long it took you to do the puzzle the first time. Use the chart on the next page. Do the same puzzle a second time and write down the time it took.

← H 50

Do the same puzzle again. Write down how long it took you the third time.

Exploration 5. Keep on Trying

Overview

Learning by making mistakes is an easy concept to understand. However, some students lack perseverance and accept failure with an "it's too hard" or "I can't do it" attitude. Here is a chance to make the point that a difficult job gets easier as we repeat it and learn the pattern for success.

The students have learned many things by trial and error and will be able to list some of them after the class gets started. Students have already used charts so they should encounter no difficulty with the chart in this lesson.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) describe trial-and-error learning.
(2) demonstrate that learning may involve making errors.

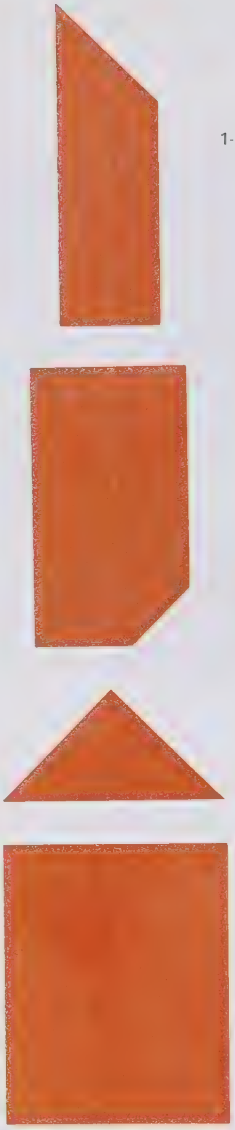
Materials for Each Group

scissors
stopwatches or clocks with second hands

Time

One day

Hard cover users: To reproduce the puzzle for this Exploration please turn to page T 57 or direct students to the Laboratory Supplement.



Trial	Time
1.	Varies.
2.	
3.	

1-3. Is there any difference in the time you took for each of the three trials? Usually, yes.

Why do you think there is a difference? One learns by trying and making mistakes. Each time it gets easier.

Check Yourself

1. What do you think is meant by trial and error learning? Learning in which we profit from mistakes.

2. Give an example of trial and error learning in another animal. A mouse learning its way through a maze. Housebreaking a dog. A bear riding a bike.

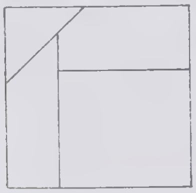
3. What are some ways that you have used trial and error learning in everyday life? Learning to tie a shoe, to eat with a fork, skating, dancing, writing, and others.

4. Can trial and error be used in school work? Give some examples. Yes, sometimes. Skills in gym, sewing, shop, typing, some math problems.

1. The puzzle should be cut out carefully so the parts will fit together properly.

2. One student will be a timekeeper while his partner does the puzzle three times, then the two can change places.

3. Once in a while a student does the puzzle quickly the first time and then takes longer for the other trials. Point out that the first time may have been a lucky one.

4.  Solution to the puzzle.

Exploration 6. Problem Solving

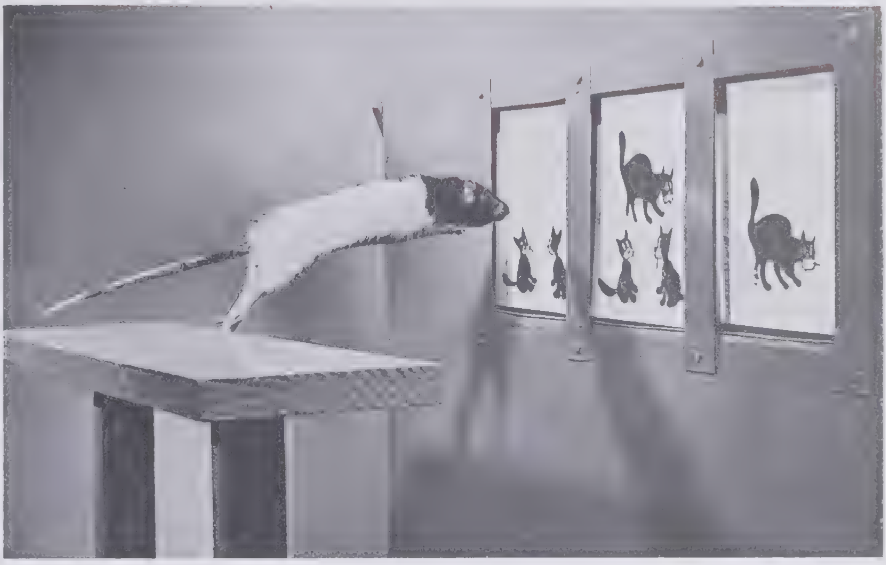
Overview

This activity exposes the class to an exercise in problem solving but it is also an exercise in grouping or classifying. Some guidance is needed to get started in the thinking process. It is easier to keep the class working together at least when you do Part One. Work slowly as you move around the room and try not to lose any of the students. This is a place where students should help each other. If you play the games, involve as many students as possible as contestants, timekeepers, or scorekeepers.

The students know that most of their behavior is learned. A few minutes of discussion will help them realize that they can often solve problems that they could not have anticipated.

Exploration

6. Problem Solving



This rat has learned to jump at two cats. There are food pellets behind the right card.

1. SOMETIMES you can get the answer to a problem in a sudden flash. It just comes to you. Sometimes you have to plan how to attack a problem.

In this lesson you will look at some ways to face problems and try to solve problems.

2. Part One I've Got Your Number

One of you thinks of a number from one to eight. The others try to guess it by asking questions. You will see there is a right way and a wrong way to ask questions.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) discriminate between trial-and-error and reasoning as problem-solving techniques.

(2) use a step-by-step method of solving problems by elimination.

Materials for Each Group

pencil

"password" game (can be home-made)

Time

Two days

1. You will know the class is involved in the learning process if students are doing most of the talking during a discussion. If this is not happening, make a special effort to get the students involved. You might tell them an interesting problem you had and ask the class to suggest ways to solve it. Sometimes these young people think that they are the only ones that have problems with mice, roaches, friends, parents, and teachers.

2. Part One This activity can be handled by having the whole class work together and progressing slowly from question to question. Be sure that the student understands that the problem is to guess the number the person is thinking of. They are told that it is between 1 and 8. The first two questions and answers are given to show them how to limit or eliminate several possibilities at a time. Encourage suggestions for the third question.

Here is an example of how the game might go.

Question: *Is the number more than four?*
Answer: *No.* (This answer tells you that the number is four or less.)
Question: *Is the number more than two?*
Answer: *No.* (This tells you that the number is two or less.)

Question: Is it one? or Is it two?
(You write the best question to ask.)

Would the answer to your last question tell you the number?

Yes.

Why is it better to ask these questions than to take a wild guess?

Because there is a plan.

What is the plan behind this group of questions? Each question eliminates possible answers.

Now repeat the game. Choose someone to think of a number.

Rats get food pellets for making the right choices. People get paid.

→ H 51

Notice the photos of the rat learning experiment and the mailman. Although these pictures illustrate problem solving, they also involve habits and other cognitive processes.

3. Part Two This list is planned so that this part can be worked on by the class as a whole, or in small groups, or individually. If groups or individuals are working, the teacher should circulate and observe the progress. Avoid "telling" an answer. It is important that the students actually cross out the items on the list as each word is eliminated.

4. There are several possibilities for questions that the student asks. Your answer will, of course, depend on the question that is asked and will be the key to the student's next question. The answer is George Washington.

Hard Cover Folios Preceded by H

What did you have to know about numbers in order to play this game? **How to count and understand number concepts. A two-year-old might count but can't play this game.**

Where did you get this information? **From school, home, or reading.**

3. Part Two Which One Is It?

Now see if you can find the one item on the following list that we are thinking of.

eye
George Washington
feet
eagle
dog
stomach
Aretha Franklin
James Bond
Abraham Lincoln
Martin Luther King, Jr.
Ralph Nader
lion
San Francisco
Lassie
brain
elbow

4. Look at the list as you follow the questions and answers.

Question: *Is it part of an animal?*
Answer: *No.* (Check off on the list those items that you know can't be the right answer.)
Question: *Is it a person?*
Answer: *Yes.* (Check off all the items that are not persons.)
Question. *Is the person we are thinking about alive?*
Answer: *No.* (That rules out some of the names. Check them off.)

← H 52

Now what items are left on the list? **George Washington, Martin Luther King, Jr., Abraham Lincoln.**

Question: Let student respond. As an example: Was the man a president?

(You write a good question to ask.)

Answer: Your teacher will answer your question with a Yes or No.

Are any items left on the list? Yes. Lincoln and Washington.

Question: Was he the first U.S. president?

(Write another question.)

Answer: Your teacher will answer your question Yes or No.

Now can you guess which item on the list we were thinking of?
These questions lead to Washington. Other questions will lead to Lincoln or King.

What is the advantage of asking questions rather than taking a wild guess? It is a plan or pattern to eliminate groups of answers.

What are some of the things you had to know about the items on the list before you could solve this problem? Parts of body, kinds of animals, whether persons were living or dead, among others.

Where did you get your information about the items on the list?
From TV, reading, school.

Page 53 (Hard Cover Text). The hard cover text has three photographs of a chimpanzee that do not appear in the soft cover version. The chimp has learned the sign language used by human deaf-mutes.

Answer to caption: (top) "hear"
(middle) "smell"
(bottom) "see"

If you put a limit on the number of questions, is it a better game?

Makes it more exciting because you are less likely to succeed.

5-6. Part Three Try It Yourself!

← H 54

Now you can play *Password*, *Twenty Questions*, or *What's My Line? Twenty Questions* is the same game as Part Two, with a limit on the number of questions.

In what way are you solving problems when you play these games?

The problem is getting to the right answer.

Why is it better to think and plan carefully instead of making wild guesses when playing these games? To eliminate many wrong answers by planning responses.

Check Yourself

Past experience and knowledge were useful to you in the problem-solving games you have played in class. How can your experience and knowledge help you in solving these problems in everyday life?

1. Choosing your friends. Let students speculate.
2. Getting along with your parents. Let students speculate.

5. **Part Three** A home-made game of password can be used. Use the following list of words. Write each word on two separate cards and hand one to a contestant on each of two teams. Five students at a time can participate, four as contestants and one as master of ceremonies. The rest of the class is the audience. Words that have been learned in class can be written on the cards.

6. behavior
inborn
tadpole
migration
hibernation
learning
problem
queen
habit
earthworm
stimulus
response
burrow
vibration
nest
egg
environment
neighborhood
insect
frog

3. Getting good grades. Let students speculate.

4. Choosing your subjects for next year. Let students speculate.

5. What other everyday problems can you add to this list?

Let students speculate.

Part One

TRIAL AND ERROR · PROBLEM SOLVING · INBORN · HABIT · CONDITIONING

What kind of human behavior is each of the following activities? Choose your answer from the five words above. Put one letter of your answer in each square of the puzzle. Number 5 has been filled in as an example.

1. Having good table manners
2. Sneezing
3. Deciding whether to take a typing course
4. Blinking in a bright light
5. Deciding whether or not to smoke
6. Learning a new dance step
7. Doing a math problem
8. Being on time for school every day
9. Learning to tie your shoes
10. Pavlov's experiments with dogs
11. Deciding what color to paint your room

1	Ⓗ	A	B	I	T									
2	I	N	B	Ⓞ	R	N								
3	P	R	O	B	L	E	Ⓜ	S	O	L	V	I	N	G
4	I	N	B	Ⓞ	R	N								
5	**P**	**R**	**O**	**B**	**L**	**E**	**M**	**Ⓢ**	**O**	**L**	**V**	**I**	**N**	**G**
6	T	R	I	Ⓐ	L	A	N	D	E	R	R	O	R	
7	Ⓟ	R	O	B	L	E	M	S	O	L	V	I	N	G
8	H	A	B	Ⓘ	T									
9	T	R	I	A	L	A	N	D	Ⓔ	R	R	O	R	
10	C	O	Ⓝ	D	I	T	I	O	N	I	N	G		
11	P	R	O	B	L	E	M	Ⓢ	O	L	V	I	N	G

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 30 or direct students to the Laboratory Supplement.

Use Your Wits! Before the students do the puzzle they may need to read the information that's on the back side. Remind them to fill in the squares starting at the far left side of the puzzle.

When you have finished, write the letters that are in the circles in each row. H O M O S A P I E N S

What does this mean? Human beings

Part Two

When a person drives a car, he uses many kinds of behavior. Try to choose the best word in column B to match each term in column A.

COLUMN A

1. Choosing a car c,d
2. Stop at a red light b
3. Pull over to the curb at the sound of a siren b
4. Pupil of the eye opens for driving in the dark a
5. Step on the gas to make the car go faster b
6. Learn how to park next to a curb c
7. Follow a map to get to another city d
8. Turn on a signal blinker light just before you go around a corner b

COLUMN B

a. Inborn behavior
b. Habit
c. Trial and Error
d. Problem Solving

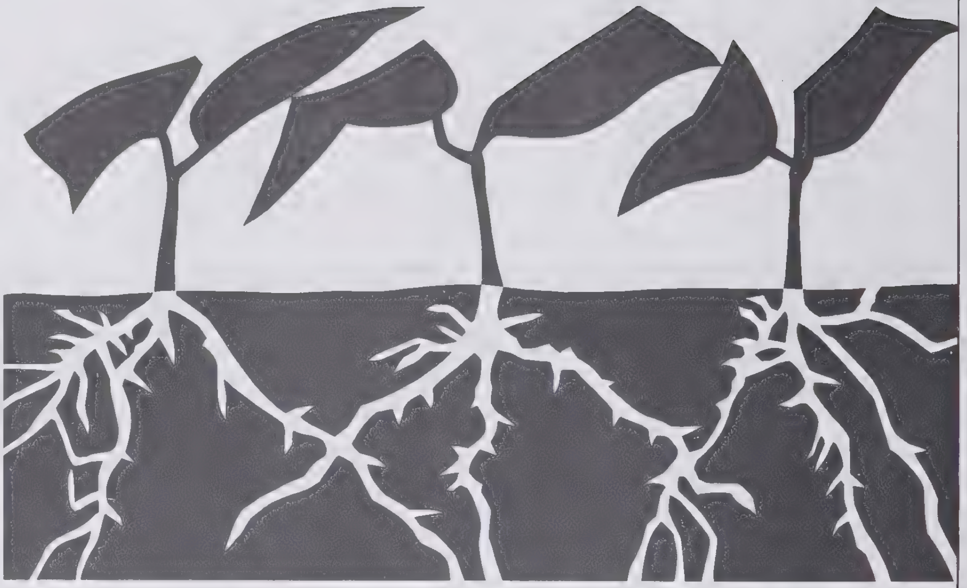
3 Plant Behavior

← H 55

T162

→

H 56



Hard Cover Folios Preceded by H

1. In the fall of the year the weather gets cooler and the days get shorter. Then the leaves on some trees turn into the beautiful colors of a fire. After a few weeks they dry up and fall to the ground. The trees are left bare all winter.

2. If you live in the western part of the United States, in places like Los Angeles or Reno, you may never have seen autumn leaves. But if you live in the East, in places like New York or North Carolina, you have.

These winter-bare trees are called **deciduous trees** (*dih SIHJ oo uhs*). They grow only in the cooler climates of the world.

Reading 1. Colorful Responses

1. In some parts of the country the fall display of colorful leaves is very spectacular. A few branches with autumn leaves might be brought into the room. Use fall pictures to brighten up the bulletin board.

2. Remind students that trees without leaves are not dead.

3. Autumn leaves are often red, orange, gold, and yellow. These bright colors are also in the leaves during the summer, but they are hidden by the green color of **chlorophyll** (*KLAWR uh fihl*). In autumn, the chlorophyll breaks down and disappears. Then the other colors can be seen. You might enjoy reading about autumn leaves in *Fall Is Here!* by Dorothy Sterling.

Trees respond to the environment, just as animals do. When the weather gets colder, deciduous trees take in less water. A hard layer forms between each leaf and branch and makes it easy for the tree to shed its leaves.

4. The bare tree stops growing. It is still alive, though, and in the spring will sprout new leaves. This tree is **dormant** (*DAWR muhnt*) during the winter. Dormant means inactive or asleep. A dormant tree is something like a hibernating animal.

Many trees, like the pines and the spruces, are called **evergreens**. They are green all winter long. They *do* shed their leaves, but only a few at a time. The evergreens don't have flat leaves like deciduous trees. Evergreen leaves are usually long, thin, and pointed like needles. As they drop off, new ones grow out of the tip of the branch.

Evergreens do not become dormant during the winter. But they do respond to their environment. They grow very little when the ground is frozen. Can you guess why?

Are Christmas trees deciduous or evergreen? Evergreen.

3. Anthocyanin is a pigment that produces blue to red coloring in plants and flowers. This pigment is not an example of a color that has been hidden by chlorophyll. **4.** The alternate periods of growth and dormancy (winter) are responsible for the annual rings of a tree. Many students know that the age of a tree can be determined by counting rings. A light and dark ring together represent a year. The lighter rings show growth during spring. The darker rings represent summer wood.

Exploration 2. Detective Work

Overview

In this Exploration students will make and interpret a chromatograph. Good results will be obtained if the students handle the material carefully and follow directions. The students will realize that chromatography is useful in identifying substances.

Behavioral Objectives

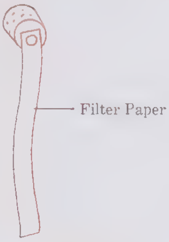
After completing this Exploration, the students will be able to

(1) make a chromatograph.

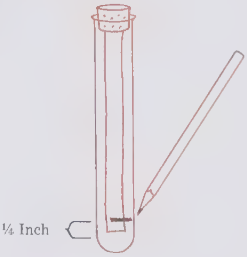
(2) interpret a chromatograph.

Exploration
2. Detective Work

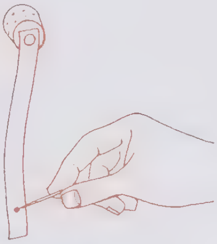
1. TODAY YOU are going to learn one way to take something apart. It is a food coloring, which is sometimes used in cooking. In the next lesson, you will take apart the color of leaves in the same way. FOLLOW THESE DIRECTIONS CAREFULLY. PLACE A CHECK (√) NEXT TO EACH DIRECTION AFTER YOU HAVE DONE IT.



2. ( ) 1. Get a large test tube and a cork to fit it.
( ) 2. Cut a strip of filter paper as long as the test tube and narrow enough to fit it.
( ) 3. Fasten one end of the filter paper to the cork with a thumbtack.
( ) 4. Now test the size of the paper. Place the cork with the paper attached in the test tube. Make sure that the paper *does not touch* the sides or the bottom of the tube. If it does, trim the paper to the right size.

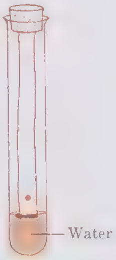


3. ( ) 5. Mark the outside of the test tube about ¼ inch above the lower edge of the paper.



4. ( ) 6. Remove the cork and paper from the tube. Use a toothpick to carefully put a small spot of food coloring on the paper about ¾ inch from the bottom. A small spot will give the best results. Let the spot dry. Then place another one in the *same place* and let it dry.

( ) 7. While the paper is drying, fill the test tube with water up to the mark on the test tube.
5. ( ) 8. Put the cork and paper back into the test tube. The bottom of the paper should just touch the water. Make sure the spot of coloring is not in the water.
6. ( ) 9. Place the test tube in a rack. Watch it until the water soaks almost to the top.



Materials for Each Group

food coloring
chromatography or filter paper strip
thumbtacks
large test tubes
corks to fit tubes
scissors
wax pencils
rack to hold test tubes upright
toothpicks

Time

Two days

1. This lesson can be done in groups or individually. It introduces the technique of chromatography and provides a good background for the next lab lesson.

2. The strips of chromatography paper can be cut to size by the teacher if he wishes. If chromatography paper or filter paper is not available, white paper towels or heavy white paper napkins can be used.

3. Blue food coloring will separate into definite bands better than the other colors.

4. Wright's stain, ink, or Magic Marker will make good chromatographs. Instructions must be followed carefully.

5. It is especially important that the tip of the filter paper touch the water but that the dot of color is *not* submerged. If the color is underwater, have the student cut a new strip and start over.

6. If test tube racks are not available, a wide mouthed

→ H 60

What happens to the paper? Paper is absorbing the water.

What happens to the spot of color? Color is separating. Usually shows bands of different colors.

( ) 10. Remove the paper from the test tube and let it dry. Look at your results and answer the following questions:

What food coloring did you use? Answers vary.

What colors do you see on the filter paper now? Usually bands of different colors.

Why can we say that we have taken the food coloring apart?

7. Because now we can see the colors that were mixed to form the food color that was used.

Why do you think the colors separated as the water soaked into

8. the paper? Some colors moved faster than others.

Research You Can Do

You might like to try to separate something else into its parts. Repeat this exploration using another food coloring or an item your teacher suggests.

bottle will hold a large test tube upright. Try it first.

7. A special mark can be given for technique. Put an A or + on the top of the lab paper if the student is doing a good job.

8. Compare the chromatographs of groups that are using the same color. Try to get the class to suggest that each material will give the same chromatograph.

Exploration 3. A Look at Autumn Leaves

Overview

By this time the students have studied animal responses to changes in their environment. Building on this, the students will concern themselves with plant responses to the environment. We will move from the familiar to the less familiar as we go from the autumn color changes in leaves to the less obvious responses.

The experience with the food coloring chromatograph will make this Exploration easier to handle. The color separation is not as obvious as it was in the last lesson. Students must follow directions very carefully while doing the activity in Part Two.

Exploration
3. A Look at Autumn Leaves

1-2. In this lesson you will examine the coloring of some deciduous leaves.

3. Part One Fresh Off the Tree!

If you can, bring some autumn leaves into class.

What colors do you see in the leaves? Answers vary.

What color were these same leaves during the spring and the summer? Green.

What changes in the environment might account for the color changes in the leaves? Weather gets colder, less moisture in the soil, shortened length of day.

What changes in the environment might account for some trees shedding their leaves? Same as above.

4. Part Two Green Is a Cover-Up

Watch your teacher remove the colors from a green leaf by boiling it in alcohol.

What color was the leaf before it was put into the alcohol? Green

← H 61

What color was the alcohol after the leaf was taken out? Green

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) demonstrate by chromatography that green plants contain a number of different pigments.

(2) give reasons for the loss of color in the leaves of deciduous plants.

(3) give reasons for the loss of leaves in deciduous plants.

Materials for Each Group

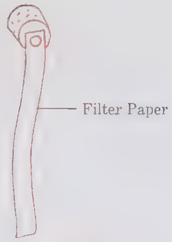
autumn leaves
large test tube with cork to fit
thumbtack
chromatography paper or filter paper
scissors
wax pencil
rack to hold test tube
toothpicks

Teacher Materials

green leaf
alcohol to extract chlorophyll
burner
water bath
solvent (½ ethyl ether and ½ acetone)

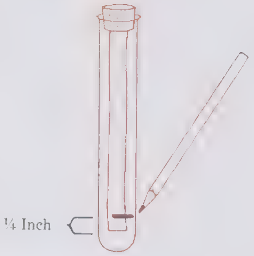
Time

Two days



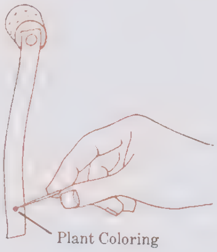
What do you think happened to the leaf? Green color dissolved in the alcohol, leaving leaf almost colorless.

Now, use the same method you learned in the last lesson to examine the true coloring of deciduous leaves. Follow these directions *carefully*. Place a check (√) next to each number when you finish that part of the experiment.



( )1. Prepare a test tube with a cork and filter paper as you did in the last lesson. Remember that the paper should not touch the sides or the bottom of the test tube.

( )2. Mark the outside of the test tube about ¼ inch above the end of the paper.



( )3. Using a toothpick, place a small spot of the plant coloring your teacher collected about ¾ of an inch from the bottom of the paper. Let it dry. Put another drop in the same place. Let it dry. Repeat this several times until the spot is very dark. Let it dry.

( )4. Put the liquid the teacher will give you in the test tube up to the mark you made. (Do not use water.)

( )5. Put the cork and paper into the test tube. The bottom of the paper should be wet, but the liquid should not cover the spot. Place the test tube in a rack.

( )6. Watch the liquid as it rises to the top of the paper.

What happens to the paper? Moistened by liquid.

1. The students have had experience with chromatography, so this activity should go smoothly.

2. Careful work will give good results in this lesson. The check-off system helps the student do the lab work step-by-step.

3. Part One Omit this part if you live in an area where there are no deciduous trees or if you do this lesson late in the school year and there are no fall colors.

The teacher may ask the class to bring in leaves, but should not depend on their doing so.

4. Part Two Chlorophyll extract for Part One can be prepared by boiling a leaf in 1½-2" of alcohol in a beaker that is in a water bath. Spinach (frozen or fresh) can be used if no other leaves are available. An improvised water bath can be made from a larger beaker or pan in which the beaker of alcohol is set. Don't heat the alcohol over an open flame and don't let it evaporate away.

Distribute the solvent carefully. Make sure that the filter paper has been cut to size before you pour the solvent into the test tubes.

What happens to the spot of plant coloring? Separates on paper and shows different shades of yellow and green.

( )7. Remove the cork and let the paper dry.

Look at your results and answer the following questions:

What color did you start with? Green.

How many colors do you see now? Where are they located on the paper? Let students decide answer.

Where did these colors come from? Part of green color that we started with.

Which of these colors might appear on a leaf when the green disappears in the fall? Varies (usually yellow).

Why do you think the colors separated as the liquid soaked into the paper? Let students speculate. Some molecules moved faster than others.

←

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Check Yourself

1. How do you know that the green color of a leaf may be hiding other colors? Because green separated into other colors.

2. What are two things that happen to the leaves on deciduous trees as the environment gets colder? They change color and fall from tree.

3. When does a pine tree shed its leaves (its needles)? Shedding is continuous. The trees lose a few needles at a time.

4. When is a plant dormant? When it is inactive, alive but not growing.

←
H 63

IF SOMEONE took you to see some 3000 year old giants, can you guess what they would look like? They would be plants, evergreen trees called sequoias (*sih KWOY uhs*) that grow in California. They have survived so long because the environment supplies them with materials they need.

Trees and most other plants cannot move around. So they must get everything they need for living out of the soil, water, or air around them.

Reading 4. Green Food Factories

1. The students know that plants are watered by putting water in the soil. They may have seen the plants wilt for lack of water.

Plants are the only living things that can make their own food from such simple things in their environment as water and carbon dioxide. Land plants take up water from the soil through their roots. They also take in carbon dioxide through their leaves. **Carbon dioxide** is a gas that is in the air. From water and carbon dioxide, plants make a kind of sugar. You can taste it in fruits. 1-2.

The parts of the plant that contain chlorophyll, the green plant coloring, can make food. Usually, food is made in the leaves. All the other parts of the plant must have food delivered to them. Can you figure out why bare deciduous trees do not grow?

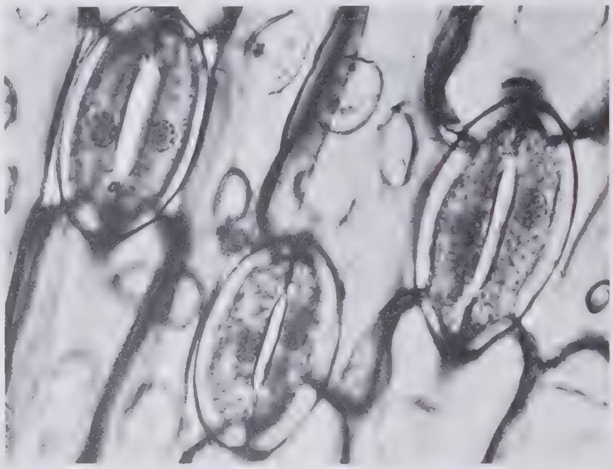
3. A green plant is a food factory running on sunlight. Plants make food by using the energy of the sun. They can also store some of the sun's energy in the food they make.

Making food from carbon dioxide and water is a basic step in supplying food for all living things. If there were no green plants in the world, there would be no animals. That is because animals eat plants or eat other animals that eat plants. So, green plants supply the energy and body-building materials for all animals.

To make food, a plant breaks down water. Water is made up of hydrogen and oxygen. The plant turns the water back into these two substances. The hydrogen becomes part of the food. Some of the oxygen is used by the plant. The rest of it escapes into the air. 4.

All living things need oxygen. Plants need a small amount. Animals need large amounts of it. They breathe in oxygen but breathe out carbon dioxide.

Plants, you remember, need carbon dioxide. So you see that animals give off a gas that plants need, and plants give off a gas that animals need. The same materials are used over and over. 5.



Gases get in and out of leaves through pores. You can see three pores in this magnified view of the bottom of a leaf.

2. Most students know that fertilizer is needed for plant growth and will suggest that this is what plants "eat."

3. In later activities, the importance of photosynthesis will be reinforced. This is the time to lay the groundwork, however. The trapping of the sun's energy is mentioned here for the first time.

4. Ask the class to try to name a food that cannot be traced back to plants. Then make a game of following it back to plant life.

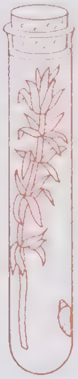
5. The last paragraph suggests a cycle. There are other cycles that the class will understand, notably the water cycle.

Exploration 5. Testing a Hypothesis

Overview

This open-ended activity gives students a chance to hypothesize. There may be some difference in the hypotheses, and the expected results may not occur. In any event, avoid agreeing or disagreeing with any suggestion. If everything dies or nothing dies, or if the "wrong" thing dies, use the results as a learning experience. Try to get the students to examine the Exploration critically. Algae in the water or on the snail, an accumulation of waste, a difference in physical condition of the living things may provide variables that will affect the results. Record their results on the chalkboard.

Exploration
5. Testing a Hypothesis



1-2. TODAY YOU will try to explain an observation. Then you will test your explanation to see if it's right.

The Observation
3. *A snail and a plant were put in pond water in a test tube. The tube was sealed so no air could get in. Four days later, the snail and the plant were still alive and seemed healthy.*

4. Think of all you know about living things and how they depend on each other. Can you explain why the snail and the plant stayed alive so long without air coming into the tube?

Write your explanation. Plant supplied oxygen for animals. Animals supplied carbon dioxide for plants.

5. Is there some way to test if your explanation is right? Yes. Repeat experiment. Set up a small aquarium and make it airtight.

If your explanation can be tested, you have just made a **hypothesis** (*hy PAHTH uh sihs*). A hypothesis is a possible explanation that you can test. It is usually a thoughtful guess.

Now plan an experiment to test your hypothesis. What would you do? Let student make plans.

Behavioral Objectives

After completing this Exploration, the students will be able to
(1) define or describe the meaning of *hypothesis.*
(2) form a hypothesis.
(3) plan a test for the hypothesis.

Materials for Each Group

1 large tube with air-tight top
snails
bunches of elodea
rack or beaker to hold tube

Time

Three days

1. Students should be reminded what a hypothesis is and what a control is.

2. We formulate hypotheses as one way of approaching and solving problems. One well-thought-out experiment should open the way to other problems. The excitement of a scientific investigation can best be learned in the laboratory.

3. Class should have an aquarium set up that includes fish and plants.

4. Several groups can work on this lesson and compare results; but it is possible to use it as a demonstration. The class will get experience using the scientific method and learn to test a hypothesis. Science should be taught in this way so the students will develop some understanding of the scientific climate for learning.

5. The activity does not have to work as expected.

6. Draw pictures to show the materials that you need. Label your drawings.

7-9. Get the materials that you need and do your experiment. Keep a record of what you see each day. Observations vary.

10. What are the results of your experiment? Various results.

11. Was your hypothesis correct? ________ Why do you think so?

Students record observations.

6. The carbon dioxide-oxygen cycle can be emphasized at this time.

7. This is open-ended enough so the teacher can guide students to other experiments. For example: A similar experiment that uses the indicator bromthymol blue. See BSCS green version.

8. If large tubes with tops are not available, use 4 oz prescription bottles.

9. Set in light but not in direct sunlight, and keep away from heat.

10. Observe at the beginning of the period each day for a week or more. This will take only 5-10 minutes.

11. The timing for this Exploration and the next two must be planned carefully. Each will take five to seven days.

12. Review what is meant by a hypothesis.

Check Yourself

1. What is a hypothesis? A possible explanation that you can test.

2. Write a hypothesis to explain each of the observations on the next page.

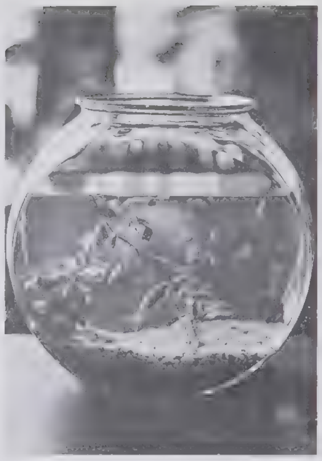
Observation 1. Student decides.

Observation 2. Student decides.

Observation 3. Student decides.

Observation 4. Student decides.

12. 3. Choose one of the hypotheses you just wrote and tell how you could test it. Answers will vary.



Observation 1. There is more air pollution over big cities than over small towns.

Observation 2. The water does not have to be changed in this bowl to keep the plants and animals alive.

Observation 3. People without high school diplomas have a harder time getting jobs than graduates do.

Observation 4. Blue jays and some other birds don't migrate south in the winter.

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Reading
6. How Much Is a Lot?

It takes a long ball to hit the center field wall at Riverfront Stadium. It's 123.13 meters from home plate.

1. You measure something when you need accurate information, not just a rough idea.

"It's a long walk." *How long?*

"She's a tall girl." *How tall: 5 feet 6 inches or 6 feet 6 inches?*

"A lot of people live here." *How many?*

"The frog is breathing slowly." *How many times a minute?*

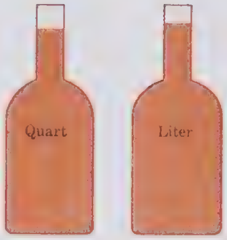
"Seeds grow quickly." *How tall? How fast?*

You can measure many different things. For example, you can

H 68

Reading 6. How Much Is a Lot?

1. Students may be familiar with some homespun methods of measuring. As an example, they may measure a yard as the distance from the tip of the nose to the tip of the middle finger when the head is turned away from the outstretched arm or an inch as about the size of the thumb from joint to tip. Ask for other ways to estimate size and weight.



A liter is a little bigger than a quart.
1 liter = 1.06 quarts.

measure time, length, weight, speed, amounts, temperature, and noise levels. There are many different measuring systems, too. The system we usually use depends on feet and pounds. People have agreed on how long a foot is and how heavy a pound is.

A thousand years ago, measurements were less certain. The foot was equal to the width of four palms or 16 fingers. Can you imagine what happened when a small man tried to sell rope to a man with big hands?

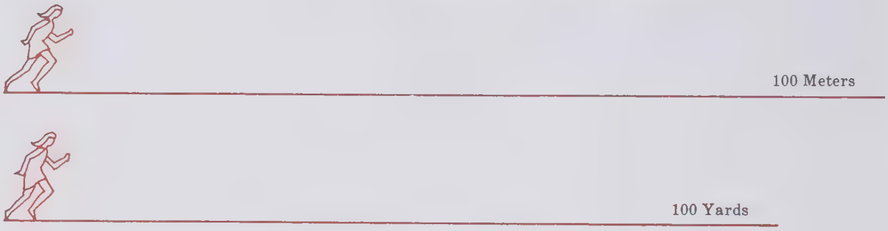
2-4. Have you ever bought 8 millimeter or 35 millimeter film for a camera? The width of both films is measured by the **metric system.** When an athlete runs 100 meters in a race, that distance is also measured by the metric system. The parts of bicycles and cars made in Europe are also measured by the metric system.

Instead of feet the metric system uses **meters.** People using the metric system buy **liters** (*LEE tuhrs*) of milk, not quarts. And they measure out candy and meat in **grams and kilograms** (*KIHL uh grams*).

5. Most of the countries in the world use the metric system. All scientists, including Americans, use it. It is important for scientists to understand each other's work. So they all measure in the metric system.

Some day the United States will probably adopt the metric sys-
6. tem. This will cause many problems until people get used to
meters, grams, and liters. Can you think of any?

Would it take longer to run 100 yards or 100 meters?



2. Many weather reports are given in both the English and the metric system.
3. Ask the students to watch the labels on food. Many food companies use the metric system. A section of the bulletin board may be set up with a display of food labels.
4. Newspapers from time to time have articles on the use of the metric system and many of them are simply and attractively illustrated.
5. Don't make an effort to have the students learn to convert the English to the metric system. All measurements in the book will be given in the metric system from this point on. Most of the measurements will be linear.
6. Our money system is similar to the metric system in that it is based on tens and hundreds. A dime is 10 pennies, a dollar is ten dimes or 100 pennies. A cent is 1/100 of a dollar. A centimeter is 1/100 of a meter.

Exploration 7. Inching Your Way toward the Metric System

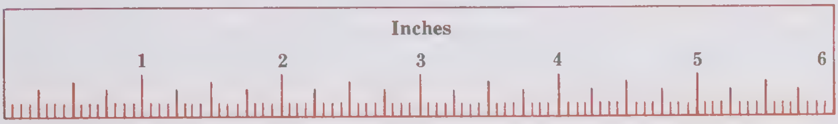
Overview

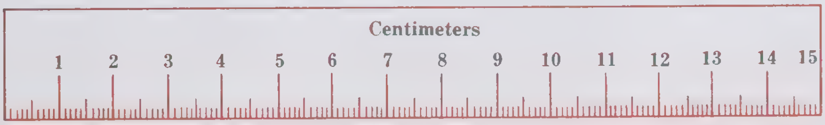
The metric system (linear only) is introduced here because it will be used in one of the following lessons. Although some of the students have difficulty handling the English system, it is necessary to expose them to the metric system. Since there is a periodic move to encourage the United States to change to the metric system, our youngsters should be aware that it does exist and that there are advantages to using it. At the same time no attempt should be made to memorize a conversion table.

Exploration
7. Inching Your Way Toward the Metric System

1-4. You are going to learn that part of the metric system needed in the next lesson. You will learn to measure length.

The ruler you will use is marked off in inches on one side and in **centimeters** on the other.





5. How long is your ruler in centimeters? Depends on ruler.

Look at your ruler. Compare the length of a centimeter with the length of an inch. Which is longer? Inch.

Explain the difference between a centimeter and an inch. Inch equal to about 2½ centimeters.

Each centimeter (cm) is divided into smaller parts. These are called **millimeters** (mm). Look at your ruler. How many millimeters are in 1 centimeter? 10.

A millimeter is what part or percent of a centimeter? 1/10 or 10%.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) use metric linear measurements.

(2) explain some advantages of the metric system.

Materials for Each Group

12″ ruler or meter sticks marked in inches and centimeters (one for each student)

pieces of chalk

Time

Two days

1. The purpose of this activity is to prepare the class for the measuring they will do in other Explorations.

2. The metric system is based on ten and it is easy to convert one unit to another.

3. The metric system is an easy way of measuring.

4. Students should become familiar with the system that they may come in contact with when they buy film, read about sporting events, use guns, or travel abroad.

5. The student should be introduced to the centimeter and meter in a way that will help him visualize these units. He should not be asked to memorize.

How many millimeters are in 6.3 centimeters? 63.

How many millimeters are in 6 centimeters? 60.

Measure the length of this page in inches, centimeters, and millimeters. Inches ______ Centimeters ______ Millimeters ______ Did everyone get the same answer? ______

6. Can you explain why? Answers vary. Differences in the way the ruler is positioned or in the way the ruler is viewed.

7. There are 100 centimeters in 1 meter. Use a piece of chalk and mark off 1 meter on the floor or on the chalkboard. How many millimeters are in 1 meter (m)? 1000.

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Check Yourself

1. How many centimeters (cm) are in 1 meter (m)? 100.
2. How many millimeters (mm) are in 1 centimeter? 10.
3. How many millimeters are in 5.2 centimeters? 52.
4. Why do you think that pearls, film for a camera, and bullets are measured in the metric system? Sold internationally. Film and ammunition must fit perfectly.
5. Scientists could measure lengths in feet and inches. Why do you think they would rather measure length in the metric system? Scientists can share and understand each other's work.

6. You will find that the metric ruler will be easy to read. The student will not have fractions such as eighths, fourths, or sixteenths to worry about.

7. Ask students this question. If the United States changes to the metric system, what are some problems that we will have?

Exploration 8. Responding to Gravity

Overview

If you ask the students whether they have been careful to plant seeds "right-side" up, they will begin to see that a response to gravity made the seeds grow "right." Whenever possible in this Exploration, stress the need for no more than one variable.

The class is familiar with organizing data tables and charts and should by now have no difficulty with them. For the first time, a graph will be used to expand the interpretation of data. Detailed instruction will be needed in this lesson. Avoid using technical terms such as axis, horizontal, and vertical. Additional graphs for classroom use appear in the Teacher's Edition.

Exploration
8. Responding to Gravity

GRAVITY is the force that pulls everything toward the center of the earth. It keeps you on the ground. If it were not for gravity, you'd fly off into space. In the next three experiments, you will see how plants respond to gravity.

1. Part One Growing Up Sideways

Set a potted plant on its side. Make sure that it will stay in one position. Watch it for three or four days.

What direction is the main stem growing in now? It is turning up.

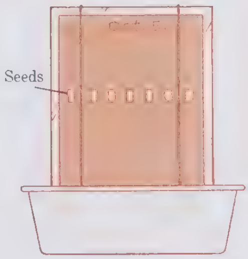
How are the leaves growing? Same way as the stem.

What do you think is the stimulus that caused this response? Gravity.

Plan an experiment to show that light is *not* a stimulus for this response. Set plant on its side in a dark closet.

2. Part Two Seed Sandwich

Cover a sheet of glass with a wet blotter. Place about 12 seeds across the middle. Cover the seeds with another sheet of glass. Hold this seed sandwich together with rubber bands.



Students know what seeds need for germination and that plants do respond to stimuli in the environment. In this activity we are adding another stimulus and watching for the response. Soak seeds in water overnight to speed up germination.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) demonstrate that plants respond to gravity.

(2) measure the growth of a plant and use a graph to record and interpret the data observed.

Materials for Each Group

potted plant
2 sheets glass or plastic at least 15 cm × 15 cm
2 rubber bands
dish with a diameter larger than one side of the glass sheets
12 or 15 seeds, radish or lentil
wax marking pencil
glass jar or beaker
blotter
cotton
8 seeds of 2 kinds: corn, bean, peas, lentil, or radish
measuring stick (in millimeters)

Time

Three days

1. Part One Cover soil in pot with foil or plastic. This will prevent drying out and prevent soil from spilling.

2. Part Two If glass sheets are used they should be

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Stand the glass on end in a dish of water. Mark the top of the glass with the date.

Look at the seeds daily until the roots are about 2.5 centimeters long. Then turn the glass upside down. Watch what happens in the next three days.

What kind of seeds are you using? Answers will vary.

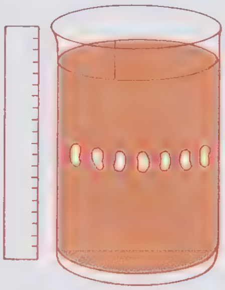
What happens to the roots when the glass is turned upside down?

They continue to respond to gravity. They grew downward.

What stimulus causes this to happen? How do you know?

Gravity. Experiment showed this.

Why can we say that the young plants respond to their environment? Gravity is a force that is part of the environment.



3. Part Three Grow, Root!

Line the inside of a glass jar with a wet blotter. Make sure the blotter is tight against the jar. Place a piece of wet cotton in the bottom of the jar to keep the blotter from drying out.

Now place about eight seeds between the jar and the blotter. Use at least two kinds of seeds. Label your jar with your name and the date. Put the jar in a warm place. Check it each day to make sure it does not dry out.

When you can see a root, measure its length in millimeters. Measure through the glass. Don't take the seed out. Record the num-

protected with tape.

The dish of water should be large enough to hold a glass standing on edge. Strong rubber bands or friction tape are necessary to hold glass or plastic securely.

3. Part Three Wide-mouth pickle or peanut butter jars can be used instead of beakers.

If the sides are straight, it is easier to keep the blotter in place. Paper towels and even newspapers can be substituted for blotters, although blotters are preferable.

A piece of wet cotton is placed in the bottom of the jar to help keep the "garden" moist.

The root can be measured right through the glass of the jar.

One way of making a graph is to have the students cut a strip of paper the exact size of the root each day. paste the strips next to each other on a piece of paper. At the end of the activity, they will have a bar graph that can be compared with the graph on page 107.

Help the students avoid a common pitfall when they make their graph. They will have the tendency to use the numbers from their chart and place them directly on the axes of the graph. Be sure that they space the numbers equally on both the horizontal and vertical axis before plotting the data.

ber on the chart below. Use a crayon to put a mark on the jar next to the seed you measured.

Every day for the next 6 or 7 days, measure the length of the *same* root. Record it on the chart.

Now you are ready to make a graph, which will give a picture of the same information in your chart. You have two kinds of information:

time (in days) and
length of root (in millimeters)

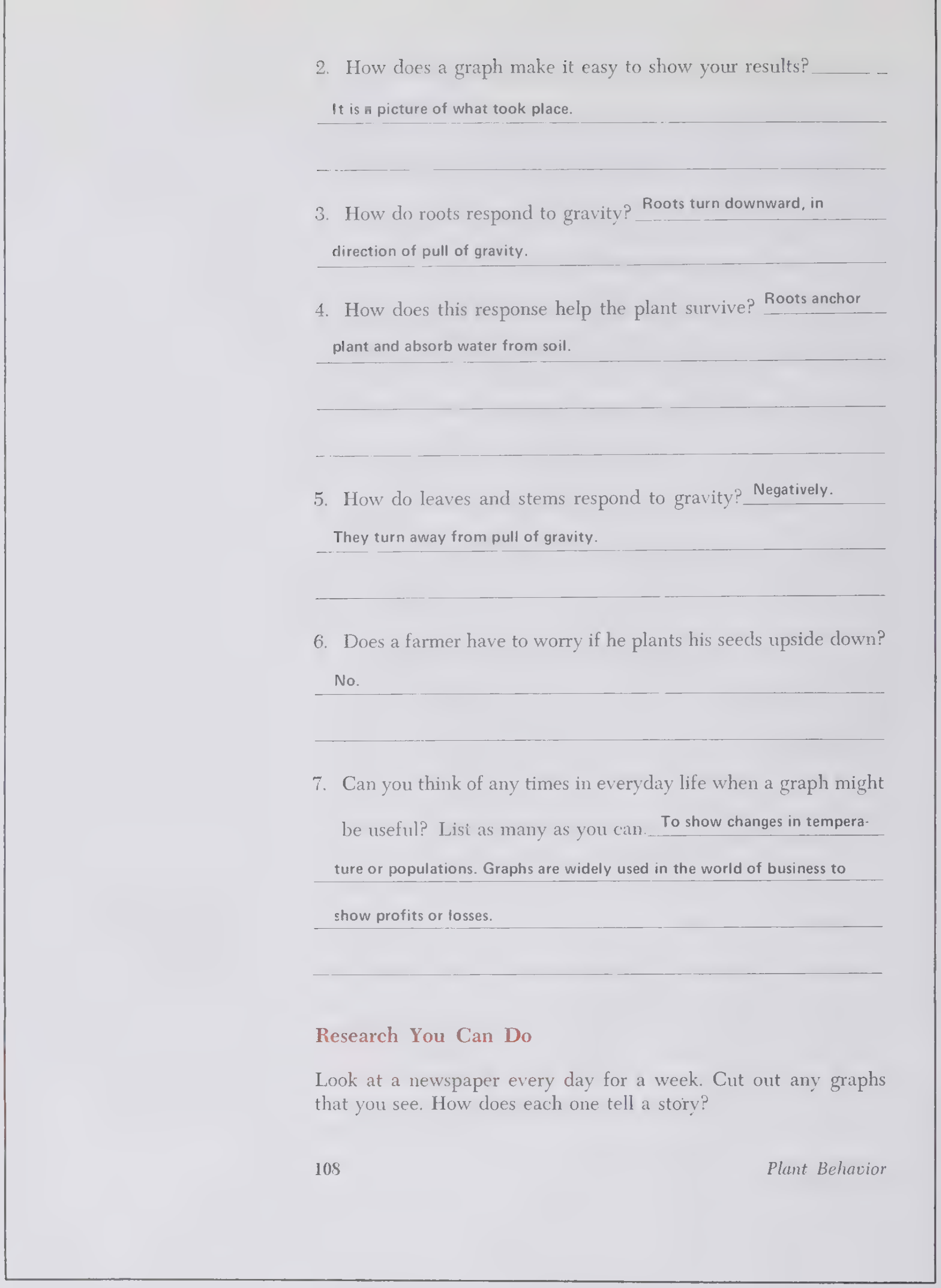
With your teacher's help, graph this information in the space below. It will help to get started if you label the left side of the grid *Length of Root*. Label the bottom edge of the grid *Days*. Then number the lines in the grid so they stand for days and millimeters.

Day	Length in mm
	Answers will vary.

Check Yourself

1. Why was it important to measure the same root each day?

You want to know how much a single root will grow over a period of days.



2. How does a graph make it easy to show your results? It is a picture of what took place.

3. How do roots respond to gravity? Roots turn downward, in direction of pull of gravity.

4. How does this response help the plant survive? Roots anchor plant and absorb water from soil.

5. How do leaves and stems respond to gravity? Negatively. They turn away from pull of gravity.

6. Does a farmer have to worry if he plants his seeds upside down? No.

7. Can you think of any times in everyday life when a graph might be useful? List as many as you can. To show changes in temperature or populations. Graphs are widely used in the world of business to show profits or losses.

Research You Can Do

Look at a newspaper every day for a week. Cut out any graphs that you see. How does each one tell a story?

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Exploration 9. More Plant Responses

Overview

The idea of plants responding to the environment may be hard for the class to grasp at first. However, they did have experience with color changes in deciduous leaves. There are no sense organs or brain to account for the reception of stimuli, so plant behavior is an intriguing idea and one that will hold the interest of the class for several days.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) demonstrate that plants respond to the environment.

(2) give examples of stimuli that plants respond to.

(3) make a hypothesis about possible plant responses and plan and carry out a test of the hypothesis.

Materials for Each Group

2 sheets of glass or clear plastic, at least 15 cm × 15 cm
8-10 lentil seeds
2 pieces of blotter, 7.5 cm × 15 cm
piece of blotter, 2.5 cm × 12 cm
2 rubber bands
dish of water
marking pencil
potted plant left on window sill
10 or 15 seeds (bean, pea, lentil)
small flowerpot with soil

Exploration

9. More Plant Responses

Morning glories open in the morning and close in the late afternoon. Why do you think some of the flowers in the picture are closed?

THE SURVIVAL of a plant depends on the responses it makes. In this lesson you will see how plants' responses help them get the things they need.

1. Part One Responses to Water

Place a wet blotter and a dry blotter on a sheet of glass. Then put eight or ten lentil seeds between them. Cut an extra piece of the

heavy paper cup
scissors
sensitive plant or Venus's flytrap

Time

Three days

1. Part One This activity will take at least a week to complete, depending on the rate of growth.

Put germinating seeds in a light place—not bright sun. Keep damp. A bonus in this lesson is that the students will learn that seeds will germinate with no soil.

If time is available after data is recorded, spend the rest of the period on Research. If you want the class to do experiments, have enough material available.

The edges of the glass plates should be taped to avoid accidents or sheets of plastic can be used.

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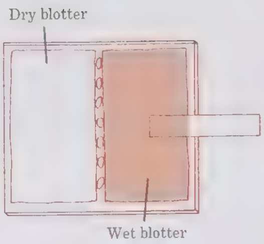
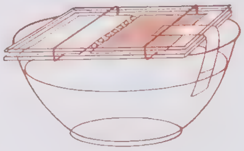


blotter about 2.5 cm wide and 12 cm long. Put this strip on the wet blotter. Be sure the seeds touch both blotters.

Lay another sheet of glass on top of the seeds and hold the two pieces of glass together with rubber bands. Set this seed sandwich on a dish of water. The extra strip of blotter should be in the water. Label your experiment with your name and the date, and set it aside. Check it each day until you see roots growing from the seeds.

What do you notice about the way the seeds are growing?

Roots grow toward the wet blotter.



What seems to be the stimulus that causes this response?

Water.

What part of this experiment is the control? Dry blotter.

2. Part Two Responses to Light

Put a potted plant on the windowsill. Keep it in the same position for several days.

What direction are the leaves growing in? Growing toward the light.

What seems to be the stimulus that causes this? Light.

What could you do to help the plant grow more evenly? If you wish, try out the best idea that you have. Turn it around periodically.

Get 10 or 15 seeds and a small flower pot filled with soil. Plant the seeds 0.5 to 1 cm deep. Water them carefully. Cut a small

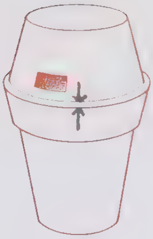
2. Part Two The seeds used should be beans or peas or lentils. If radish seeds are used, plant them ⅛-¼" deep.
To speed up the germination of seeds, soak them in water overnight. A fungicide might be used to discourage mold.

window in a paper cup. Place the cup on the flower pot. The window will allow the light to enter.

Mark the cup and the flower pot with matching arrows. This will help you keep the cup in the same position during the experiment.

Set the covered pot where it can get light for a few days. If it needs watering, set the pot in a dish of water. *Do not remove* the top.

Each day look at your experiment through the window. Watch for any plant growth.



What kind of seeds did you plant? Answers will vary.

What happens to the young plants after a few days? They will start to grow toward the window that was cut in the cover.

What may be the stimulus for this response? Light.

What makes you think so? They grow toward the light.

3. Part Three Responses to Touch

Try to get a sensitive plant (mimosa) or a Venus's flytrap. Gently touch one of the leaves.

What plant did you use? Answer varies.

What happened when the leaf was touched? Students record observations.

Does this always happen when the leaves are touched? Yes, after the plant has recovered from being handled.

What other stimuli could you use to try to get a similar response? Let students speculate. (light, cold, heat, sound)

3. Part Three If a full-grown sensitive plant is not available, it can be started from seed about one month ahead. Seeds can be put on annual order or bulbs of Venus's flytrap can be ordered. Sometimes seeds can be bought in a garden nursery. Time is needed for growth.

Many students are unwilling to give up the plants after the experiment has ended. A box or flowerpot may be provided to salvage the plants. Move them into the soil, blotter and all, to disturb the roots as little as possible.

For a time students will be collecting data for both activities. Check to be sure that the information needed is recorded. Point out the good growth in plants to the class. The student-owner will feel a sense of achievement.

Check Yourself

1. What stimuli did the plants respond to in this lesson? ______
Water, touch, light.

2. How do the responses to these stimuli help the plants survive?
Light is needed for food-making. Water is essential for life. Touch in a Venus's flytrap helps it get food.

3. What stimulus might cause a morning glory flower to open in the morning and close in the evening? Light.

4. There are some plants that open at night and close during the day. What stimulus may these plants be responding to? ______
Probably light.

Research You Can Do

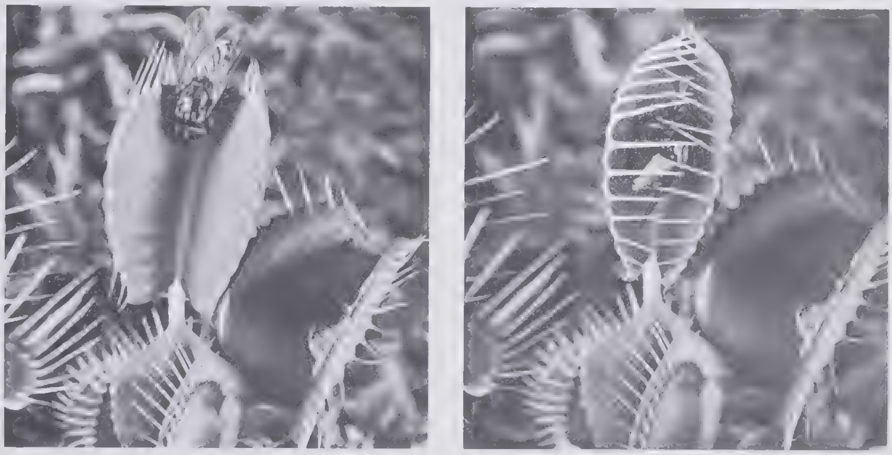
Plan experiments to answer the following questions about plants. Compare your ideas with your classmates' ideas. Decide whether you need a control. Then, if you wish, do one of the experiments.

1. Do seeds need a warm environment to start to grow? ______

2. Do seeds need water to start to grow?

3. Will plants grow better in colored light than sunlight?

A Venus's flytrap eats insects. Can you guess what stimulus makes the leaves shut tight on the fly?



4. What effect does the lack of light have on young plants? ______

5. Ask your own question. ______

You might get some ideas or experiments from this book: *Discovering Plants* by Richard M. and Deana T. Klein.

Use Your Wits!

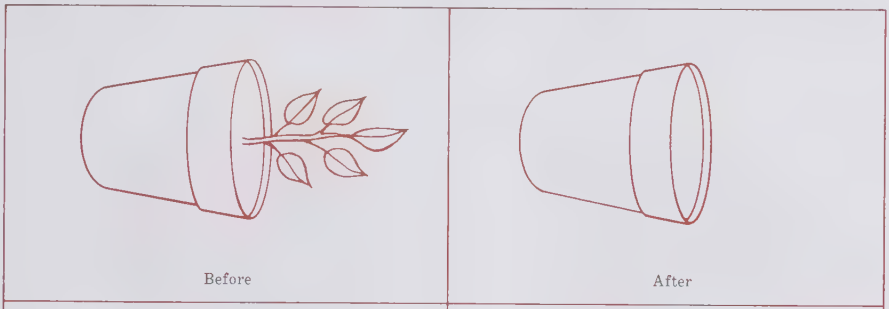
Students draw pictures in this section based on their observations of seeds and plants.

Below are 13 pairs of pictures. Think about how the plant or seed responds in each case. Then finish the incomplete picture in each pair.

You may want to score yourself. ____________________

5-6 right — Fair
7-9 right — Good
10-13 right — Excellent

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 32 or direct students to the Laboratory Supplement.



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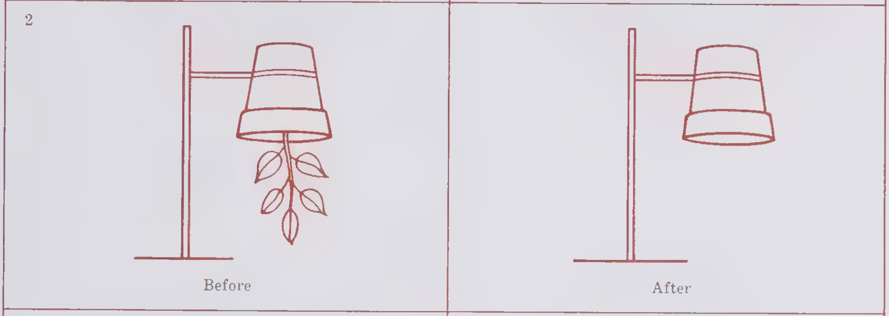

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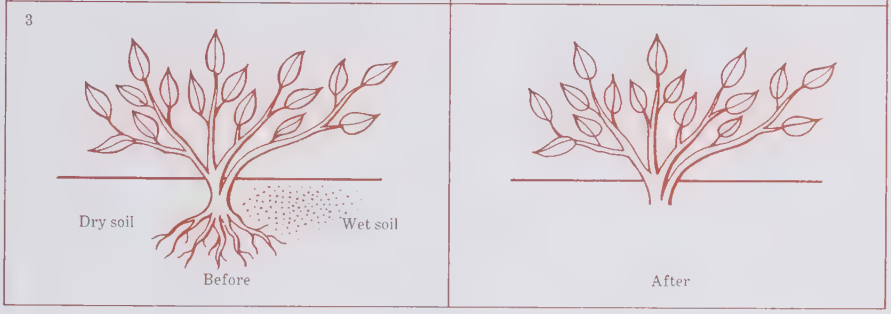

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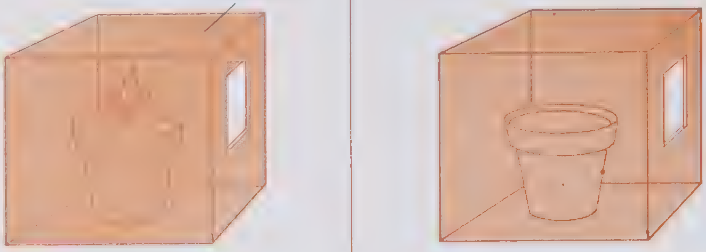
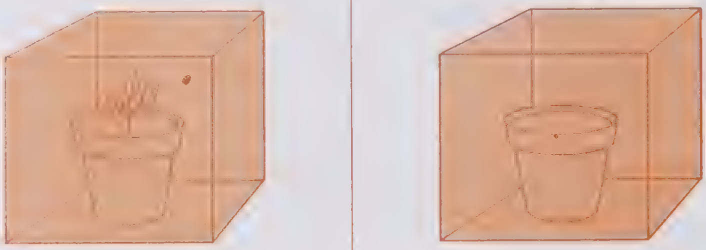


Plant should grow toward light source.

Before

After

5

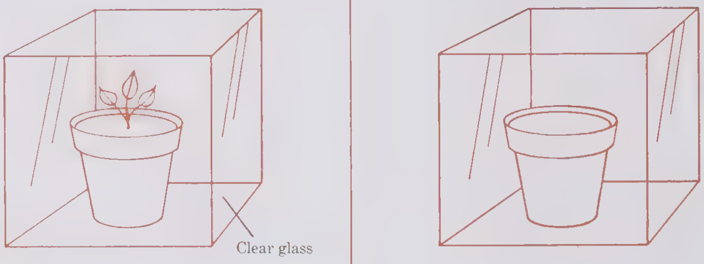


Plant should not incline toward any direction.

Before

After

6

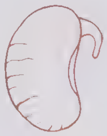


Plant should grow evenly upward.

Before

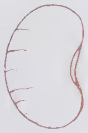
After

7



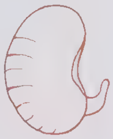
Before

Root should grow downward.



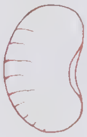
After

8



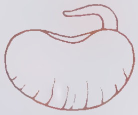
Before

Root should grow downward.



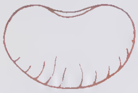
After

9



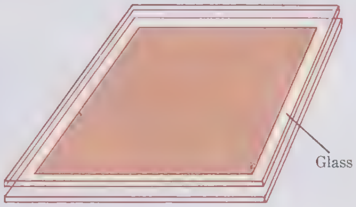
Before

Root should grow downward.



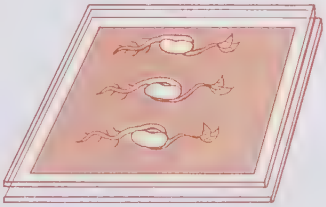
After

10



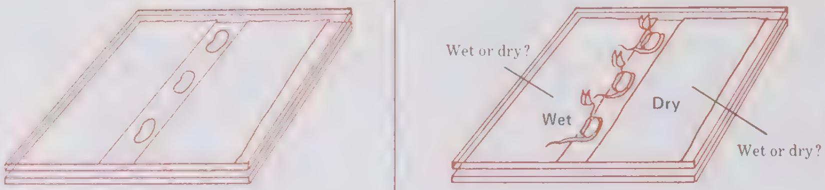
Seeds should be oriented as in No. 7 Before.

Before



After

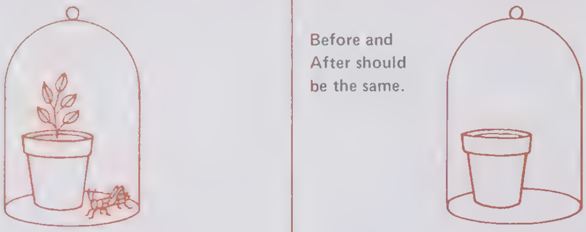
11



Before

After

12

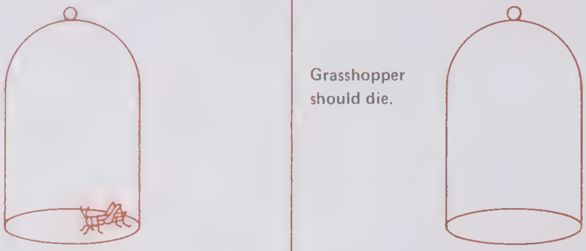


Before

Before and After should be the same.

After

13



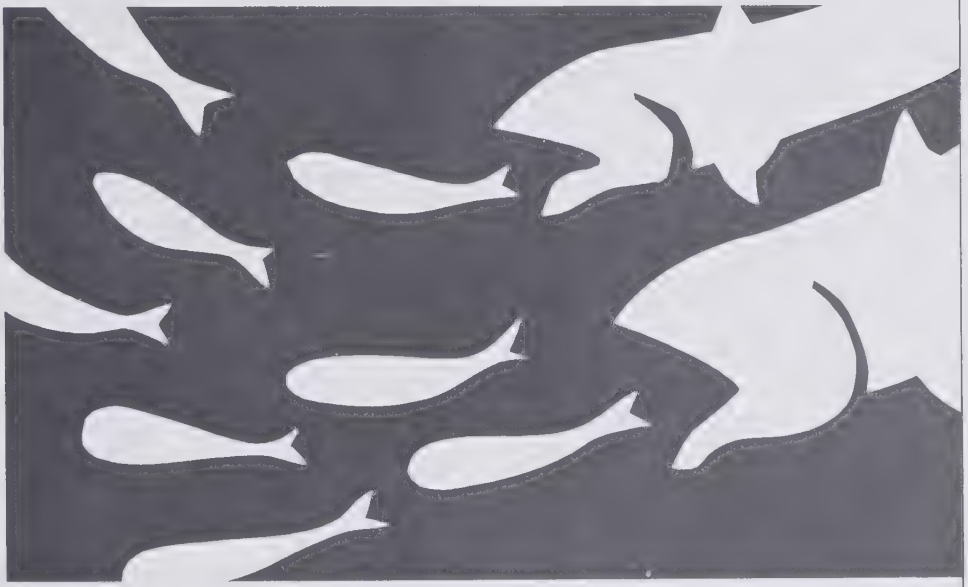
Before

Grasshopper should die.

After

4 Communities and Populations

← H 75



H 76

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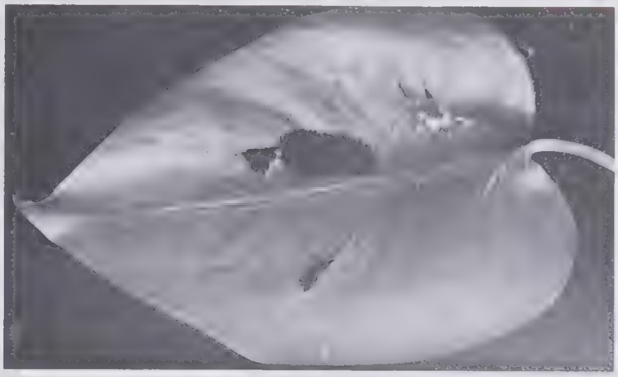
Reading
1. Food Chains



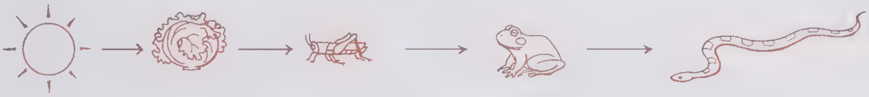
1. IF IT WERE NOT for plants, we would not be alive. Do you know why?

All living things need energy to stay alive. This energy comes from the sun. Green plants are the only living things that can trap the sun's energy. Plants store the sun's energy in the form of food.

We call plants **producers** because they produce the energy that
2. everything else needs. The living things that use the energy of the plants are called **consumers.** Consume means to eat. Consumers consume producers and sometimes each other.

When an animal eats a plant, the animal gets some of the stored energy. Then suppose a second animal eats the first animal. The second animal gets some of the energy that was stored in the first one. The sun's energy gets passed from one organism to another.

For example, a grasshopper eats a lettuce leaf. A frog eats the grasshopper. And a snake eats the frog. The four organisms make up a **food chain.** Energy passes up the links in the food chain.



The grasshopper, frog, and snake are the consumers in this food chain. The energy of the sun was first stored in the lettuce. Then it was captured by the grasshopper, then by the frog, and then by the snake. What animal could get energy by eating the snake?

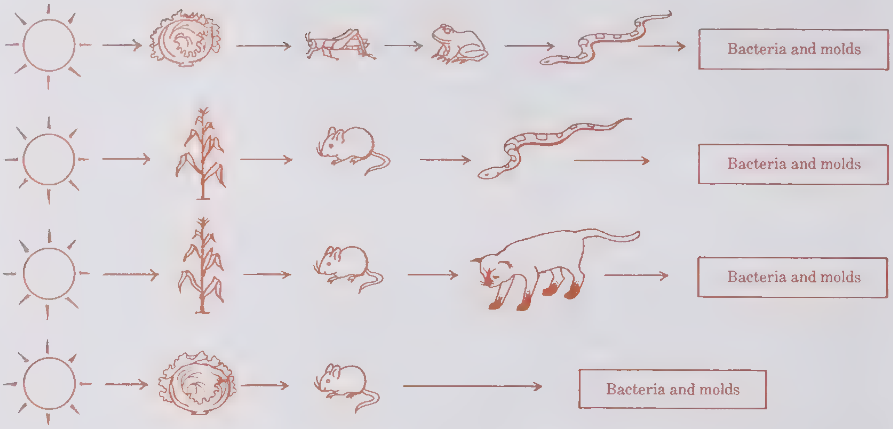
Reading 1. Food Chains

1. Write a few food chains on the chalkboard. One idea is to start with a student and what he had for lunch or dinner. Then work back to the producer and then to the sun.

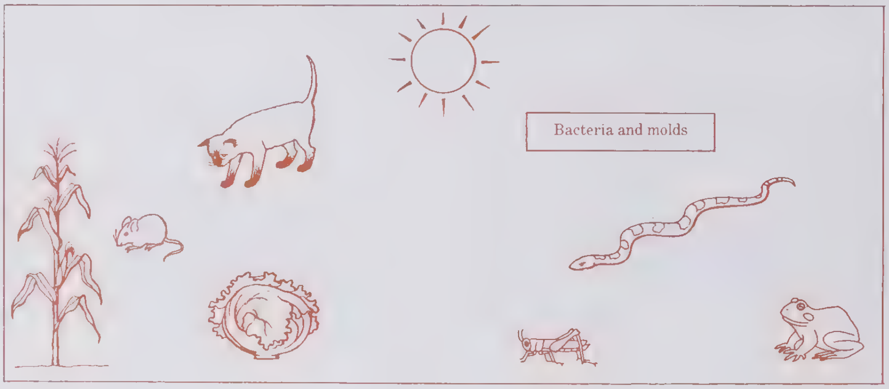
2. Be sure that the class understands that producers in a food chain may originate at sea.

Sooner or later, the plants and animals that are not eaten die.
Other animals may eat the remains. Bacteria and molds break
down what's left. Bacteria are so small that they can only be seen
3. with a microscope. But you know they are at work whenever you
see food rotting. Bacteria and molds are called **decomposers** (*dee
kuhm POHZ uhrs*). They break down (decompose) dead things.

Decomposers are an important part of the living world. For one
thing, they keep the world from filling up with dead bodies. Also,
when they decompose a plant or animal, they break it down into
4. carbon dioxide and other chemicals. These materials may be used
by other growing plants. In this way, certain materials needed for
life are used over and over again.



Here are more food chains. You can see that a plant or animal usually fits on more than one chain. So food chains link up into food webs. Draw in the arrows for the food web shown below.



Hard cover users: To reproduce the food chain for this Exploration please turn to page T 57 or direct students to the Laboratory Supplement.

3. Although decomposers are useful they may cause decay of food at home.

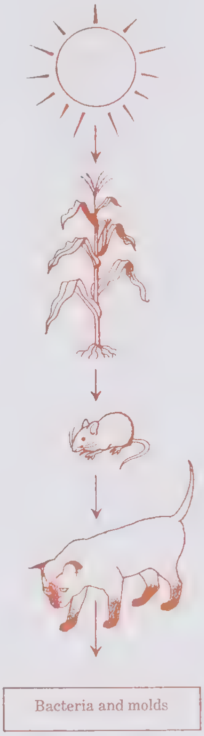
4. In nature, several food chains can interlock to form a food web.

Exploration

2. Follow the Sun

YOUR JOB today is to follow the energy of the sun as it passes from one living thing to another.

Part One Energy Paths



Study the food chain on this page.
The corn plant has chlorophyll. It makes its own food from carbon dioxide in the air and water in the soil. Its gets the energy to do this from the sun.

A mouse eats the corn. The corn's energy and some of its chemicals become part of the mouse's body.

A cat catches the mouse. Some of the mouse's chemicals and its energy now become part of the cat's body.

When the cat dies, bacteria will decompose its body. Chemicals that made up the cat's body are returned to the air and soil and may be used over again by plants.

Did some of the energy of the sun become energy for the mouse to use? Why do you think so? Yes, it went from sun to corn to mouse.

Did some of the energy of the sun become energy for the cat to use? Why do you think so? Yes, from corn to mouse to cat.

Where do dead plants and animals fit in food chains? Bacteria feed on them and the chemicals of the organisms are returned to the soil and air.

← H 79

Exploration 2. Follow the Sun

Overview

The relationship of plants and animals to each other and to their physical environment is developed in the next few activities. As the students investigate food chains and then food webs they will realize that energy flows from one organism to another. The loss of energy as it passes through the food chain is a concept that can be handled by most students at this level.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) make models of food chains and food webs.

(2) show that food chains begin with green plants trapping the sun's energy.

(3) describe how pollutants may become concentrated as they pass from one organism to another in a food chain or web.

(4) explain the loss of energy from one level to another in a food pyramid.

Materials for Each Group

transparent tape
scissors
paper
colored pencils

Time

Three days

Where do bacteria fit in food chains? They are the living things that cause decay of dead organisms.

Name other animals that could have eaten the mouse. Snake, hawk, fox, eagle.

Name other animals that could have eaten the corn. Cow, pig, insect.

Name an animal that could have eaten the cat. Wolf, fox.

1. Part Two Making Food Chains

There are plants and animals on the facing page. Arrange these pictures to build two food chains. When you are sure your food chains are correct, write them below. Here's an example.

2. 1. Energy from the sun is captured by wheat, that is eaten by a caterpillar, that is eaten by a robin, that is eaten by a cat, that dies and is decomposed by molds.

2. Students record information.

3.

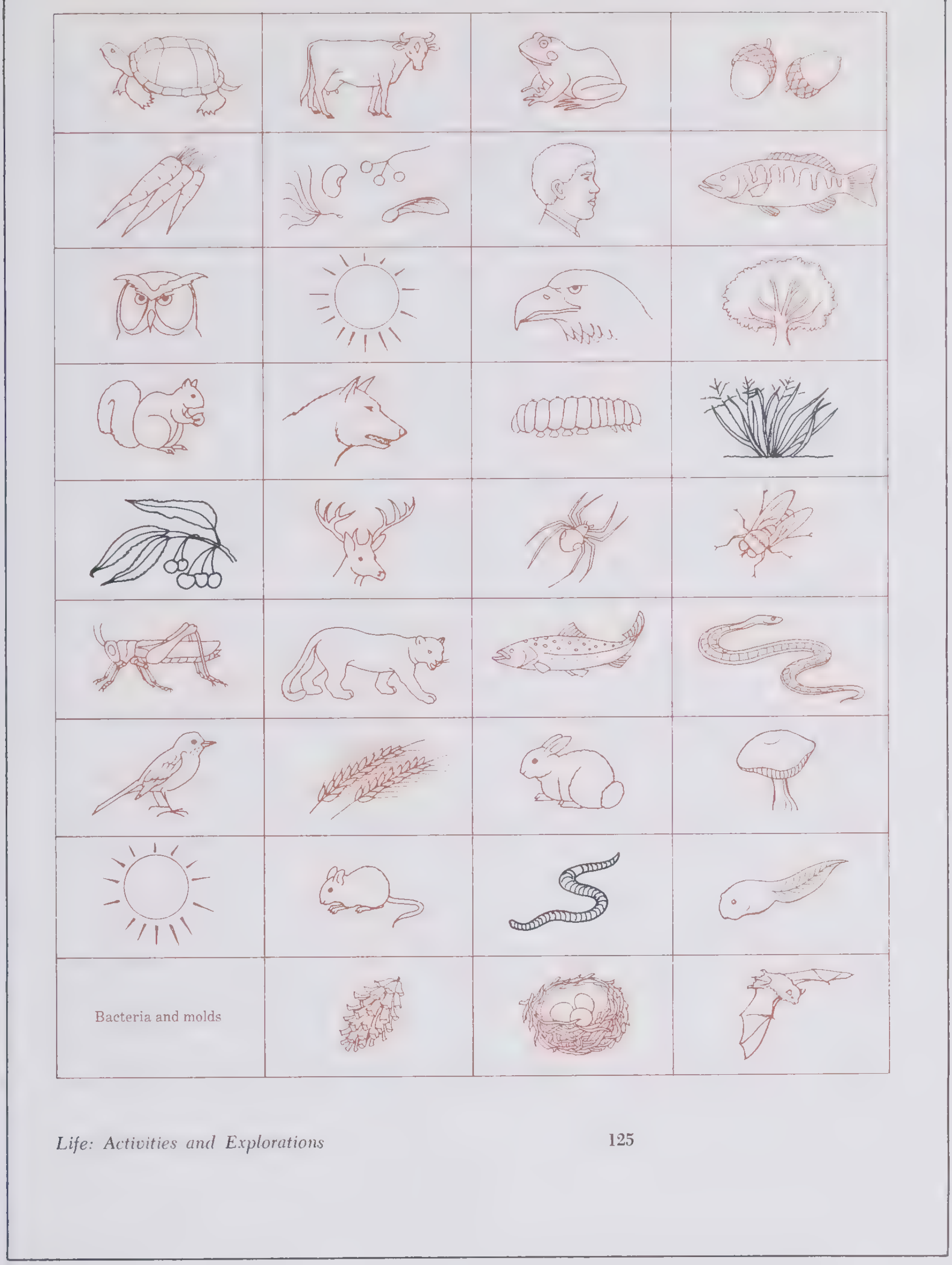
3. Part Three Spin a Food Web

Use the same pictures to build a food web. Remember that a food web is made up of several food chains linked together. Tape all

1. Students use the pictures to line up a food chain, then build food webs.

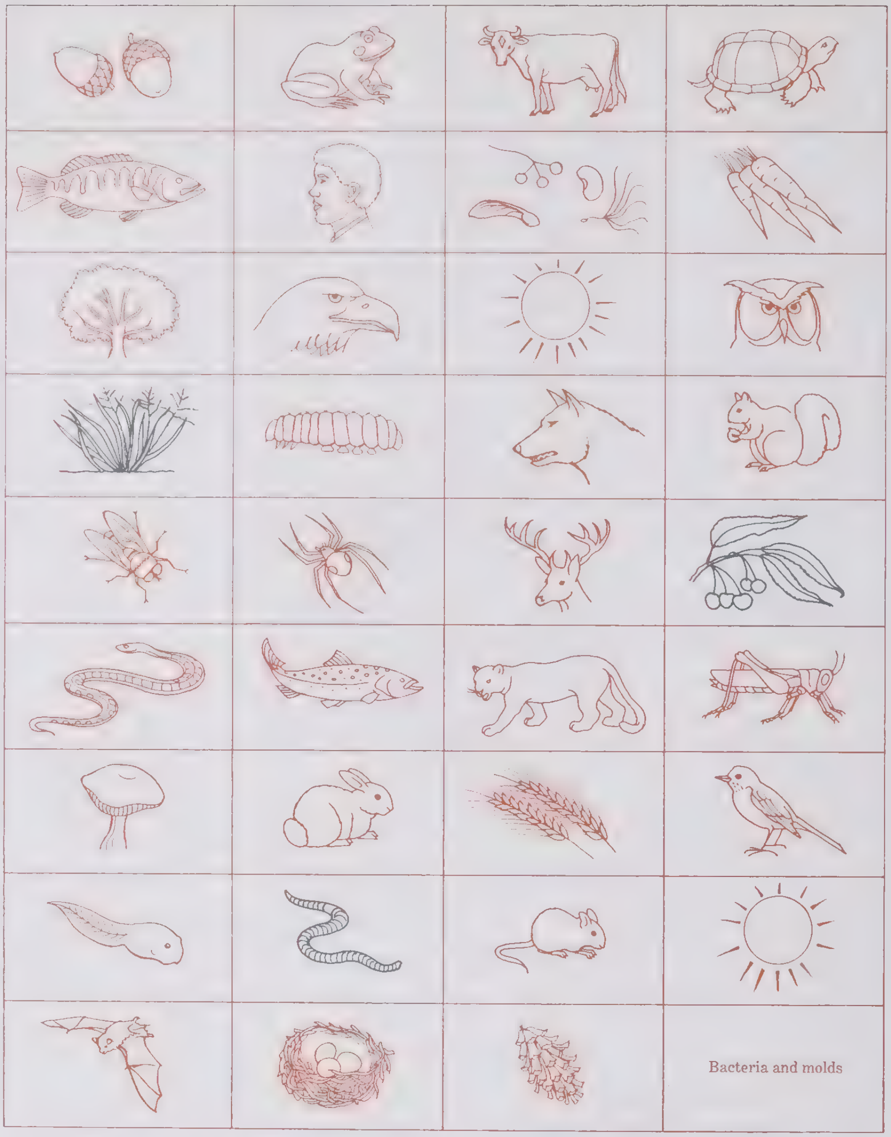
2. In time, some students will get the idea that when an animal dies and decays, a whole new chain can be started.

3. There is no place where classification per se is taught in this course. If you feel the need to include it, do so in a limited way. Let the students devise their own system of separating these pictures into groups.



Bacteria and molds

Hard cover users: To reproduce the pictures for this Exploration please turn to page T 58 or direct students to the Laboratory Supplement.


Bacteria and molds

the living things in your food web on to a piece of paper. Use arrows to show how the energy passes from one organism to another. *Do not take the web apart when you have finished.*

Look at the food web you just made. Which plants or animals are black? Pretend these organisms have been sprayed with an **insecticide** (*ihn SEK tuh syd*) like DDT or **chlordane** (*KLAWR dayn*). Insecticides are poisons used to kill insects. If other animals also eat the plants that have been sprayed, they take in the poison. The animals may not die, but the poison can be stored in their bodies.

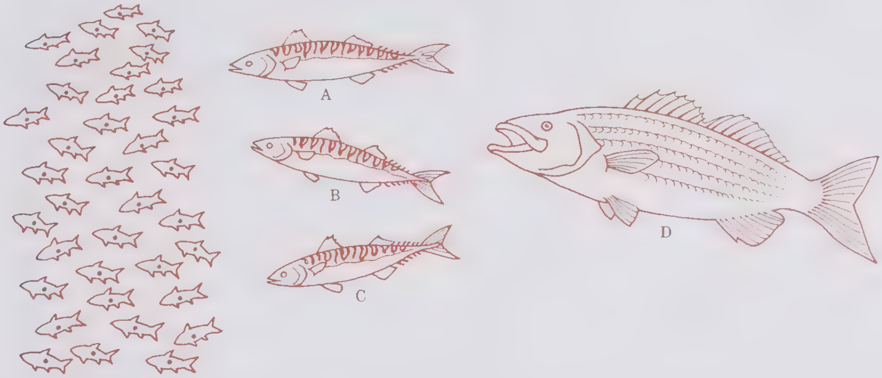
Take a pencil and color all of the animals in your food web that might take in an insecticide in their food.

What do you think can be done to stop passing insecticides from one animal to another? Let students speculate. Example, we can pass laws.

4. Part Four A Build-up of Pollution

← H 80

Hard cover users: To reproduce the illustration for this Exploration please turn to page T 59 or direct students to the Laboratory Supplement.



Look at the school of small fish in this picture. Notice the black dots. Each dot stands for a small bit of a harmful chemical. This chemical stays in the body of the fish.

Fish A eats 10 of the small fish. How many bits of chemical will be in its body? Draw this number of dots on Fish A.

4. The movement of a pollutant through the food chain should be obvious. Here is a chance to point out that materials other than insecticides may be passed along.

Fish B eats 12 of the small fish. Draw the dots to show the bits of chemical in its body.

Fish C eats 14 of the small fish. Draw dots to stand for the bits of chemical in its body.

Fish D eats A, B, and C. Draw dots to show the bits of chemical in D's body.

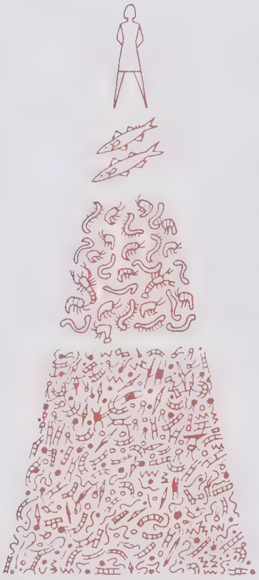
How does the amount of chemical in Fish D compare to the amount of chemical in one of the small fish? ______

Higher concentration.

What might a large build-up of a harmful chemical do to fish D?

Kill it or weaken it.

Part Five A Food Pyramid



The diagram on the left is sometimes called a **food pyramid.** Energy is passed from one level to the next. A human is at the top. At the bottom are millions of ocean plants. Some of them are microscopic. Others are big enough to see.

What do you notice about the number of animals at each level?

Number is smaller than on the next lower level.

Can you make a hypothesis to explain the decrease in numbers as you go from the bottom to the top of the pyramid? ______

Let students speculate.

← H 81

Reading
3. You Can't Do Just One Thing

DDT can keep a female eagle from laying a healthy egg. The dead egg in this nest had a very thin shell. The one baby eagle in the nest was lucky it hatched.

1. Sometimes people try to kill a group of living things that is bothering them, weeds or insects for example. Then the real trouble often begins. There is a good rule to remember when you study nature: *you can't do just one thing!*

America's elm trees are being killed by a disease that is carried by beetles. In the 1950's people, in the Mid-West and New England especially, used DDT to kill the beetles and save the trees. They sprayed the trees with DDT in the spring and summer.

In the fall the elm leaves fell to the ground and carried the poison with them. Elm leaves are a favorite food of earthworms. The earthworms didn't die from the DDT, but it collected in their bodies.

In the spring, the migrating robins flew back north. Robins can
2. eat a lot of worms, as many as one a minute. Some of the robins
died from DDT poisoning. Other robins didn't, but the DDT collected in their bodies. When they laid their eggs, the shells were

Reading 3. You Can't Do Just One Thing

1. The ideas in this Reading are basic to understanding the impact of people on their environment.

2. In some places detergents that contain phosphorus are prohibited. Ask students if they approve. Some of the chemicals that were substituted for phosphorus are caustic and poisonous.

weak. The shells broke easily, and the young robins died before they hatched.

All the people wanted to do was kill beetles. But in nature you can't do just one thing. Everything connects to everything else.

DDT was used for many years to protect crops from insects and to kill insects that carried diseases. People did not realize how much DDT was collecting in the soil and in the water. They did not know that DDT could remain deadly for years.

At least 63 other kinds of birds besides robins have been killed. Scientists think that all people in the U.S. have some DDT in their bodies.

Can you think of a food chain to show how DDT could get into your body? Let students speculate.

What pollutants could have killed these fish?

3. In the face of an energy shortage, there are objections to offshore drilling and the building of atomic energy plants. This will make a good topic for class discussion.
4. Swordfish and tuna have been found to contain high levels of mercury and have been taken off the market from time to time. Tie this in with food chains as well as with pollution.

Sulfur fumes from a nearby coal-mining area killed these trees.

Today DDT cannot be used in the United States except in emergencies. But some chemicals used in place of DDT may be just as
3. dangerous.

This is one example of how people can affect plants and animals. DDT is only one pollutant. There are a lot more — for example, fallout from atomic bombs, detergents, car exhaust, oil spills, garbage, factory smoke, and sewage. 4.

← H 83

By polluting our environment, we hurt and kill many living things. Usually the killing is an accident, but we can't replace a group of animals that is accidentally wiped out. People have also been killed accidentally by pollution. We can't replace them, either.

THE NEW CALL OF THE WILD

Exploration 4. Finding a Place to Live

Overview

The concept of interrelationships of plants and animals can be reinforced in this pencil activity. Food webs can be found in arctic, deciduous forest, and other biomes. By using books and films as well as illustrations in the text, the students are taken into areas of the world that will broaden their horizons. If students are interested, they can report on individual biomes.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) describe several different living zones (ecosystems) on the planet.

(2) list several instances of how the plants and animals in a living zone depend on each other.

(3) give several examples of plant and animal adaptations to their environments.

(4) discuss the impact people have had on different living zones.

Materials for Each Group

2 pencils
world globe (optional)

Time

Three days

1. Films and other visual aids will be good sources of information.

Exploration

4. Finding a Place to Live

← H 85

1. A REINDEER can't live in a jungle. A cactus would die if you planted
it in a pine forest in New Jersey. And a shark can't live on land.
Plants and animals are especially suited for the environments
2. they live in. Usually, plants and animals can't move to very different environments and stay alive. Either the heat or cold would
kill them. Or they couldn't find food. Or another animal they had
no defense against would eat them.
So, you see that the environment affects more than behavior.
3. The environment also sets limits on what organisms can live in a
particular place.

There are several kinds of environments or life zones that are especially important. They cover large areas of the earth and house many living things. In this lesson you are going to study three of these life zones. Let's begin with the desert.

The Arizona desert. What do you notice about the plants in this scene?

← H 86

2. If your class can handle it, the word ecosystem can be used in this lesson.

3. Reinforce the idea of food webs.

Camels in the Sahara Desert. How is this desert different from the desert in Arizona?

The kit fox lives in deserts in the Southwest. Would you expect a kit fox to be out hunting food at noon?

A horned rattlesnake, also known as a sidewinder.

Scorpions prey on insects and spiders. What weapons could they use on their prey?

Roadrunners can run 20 kilometers an hour. They eat snakes, scorpions, and other small animals.

Part One The Desert

From pictures, movies, and class work learn as much as you can about deserts. Then write a paragraph that describes the living conditions in one desert.

Let students express ideas.

What is the biggest problem in staying alive in a desert?

Lack of water.

What kind of plants can survive in a desert?

Cactus, mesquite—any that can store water.

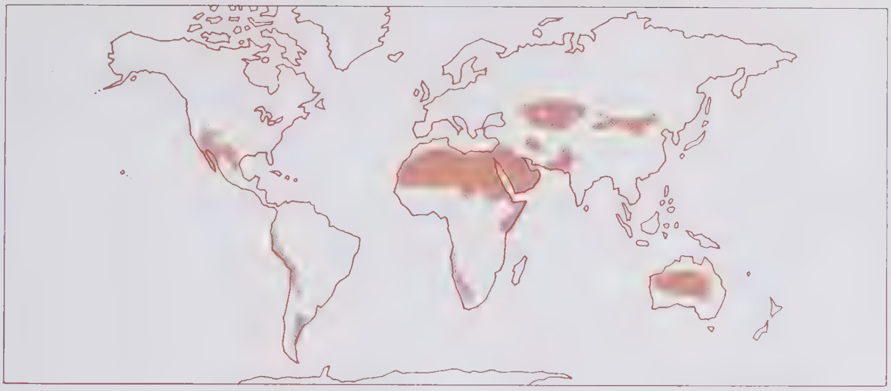
What kind of animals can survive in a desert?

Camel, kangaroo rats, snakes, lizards.

Why are many desert animals active at night and at rest during the day? It's cooler at night—less water is lost from their bodies.

Why is the camel a successful desert animal? The camel sweats and urinates very little. It can survive for days without water. Its feet are adapted for walking in sand.

Major Deserts of the World



Why is the cactus a successful desert plant? It can store water.

What are some of the ways that desert plants and animals depend on each other? Plants supply shelter, shade, water, food. Animals may pollinate plants.

What are some of the problems that people have in living in a desert? Lack of water, food, difficulties in travel and communication, shelter.

How have people solved some of these problems? Irrigation, trade with each other, use of temporary shelters (tents), plants for grazing animals, building dams. Some live as nomads.

→ H 89

Part Two The Tundra

The tundra is found far north in Europe, Asia, and North America. Typical tundra animals are shown on pages 140–141. From pictures, movies, and class work, write a paragraph that describes the living conditions in the tundra. Let students express ideas.

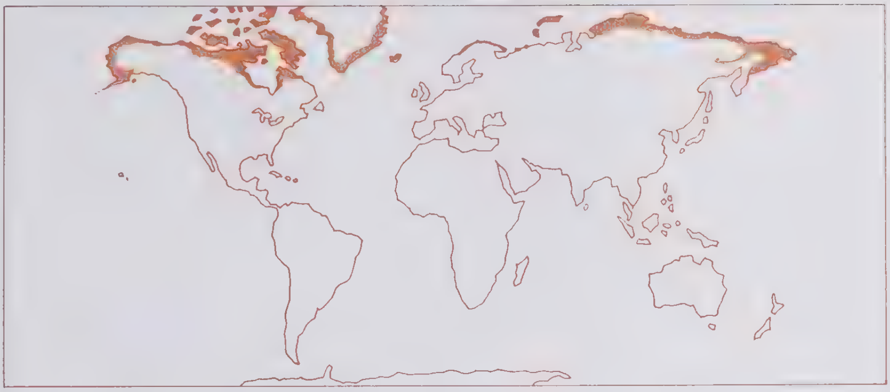
What is the biggest problem in staying alive in the tundra? Cold.

What kinds of animals have been able to survive in the tundra?

Reindeer, caribou, arctic fox, ermine (weasel), snowy owl.

The Alaskan tundra is a cold, flat, marshy place.

The Tundra Region



What kinds of plants grow in this life zone? Lichens, arctic poppy,

moss, algae,—all low-growing and hardy.

How do plants and animals depend on each other in the tundra?

Animals depend on plants for food and shelter.

What groups of people live in the tundra? Eskimos, Laplanders.

What are some ways that these people are different from you?

There is a difference in food, clothing, shelter, transportation, and kinds of jobs,

even though they are becoming modernized.

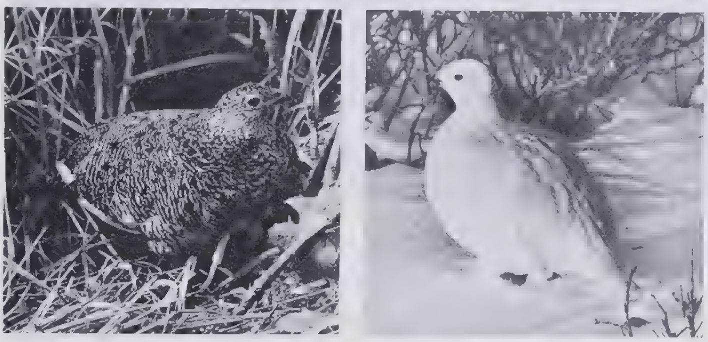
In the summer in the tundra the air gets thick with mosquitoes. Their bites have driven people and moose crazy.

When there is a lot of food around, lemmings have a population explosion. After a while, sickness brings the lemming numbers down again.

Can you find out what snowy owls eat?

← H 90

Laplanders keep herds of reindeer. They get milk, meat, and skins from the animals.



Ptarmigans (TAHR mih guhns) in summer and winter. How could their color changes help them?

A grizzly bear, the fiercest hunter of the tundra.

Part Three The Deciduous Forest

From pictures, movies, and class work, write a paragraph that describes the living conditions in a deciduous forest. Some typical forest animals are shown on pages 144–145. **Let students express ideas.**

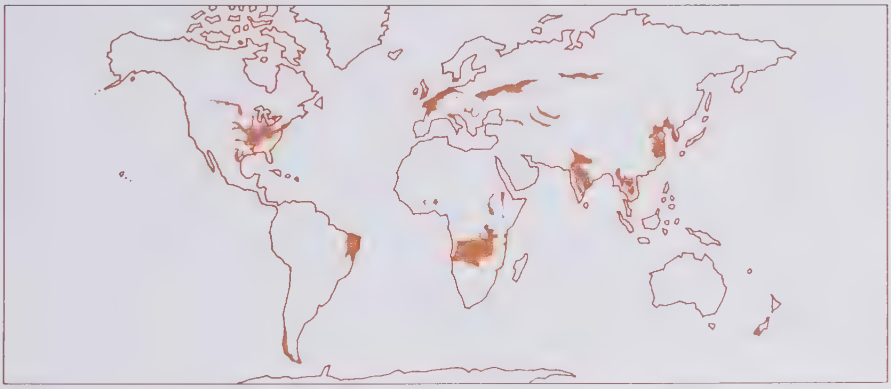
What animals live in deciduous forests? Rabbits, squirrels, mice, fox, wolf, insects, worms, birds, snakes, turtles, toads, and others.

How do these animals survive in the winter? Some hibernate, some migrate, some die after laying eggs.

What plants grow in this kind of forest? Deciduous trees, ferns, moss, funguses, flowering plants (weeds, spring flower, shrubs).

How do plants and animals depend on each other in this life zone? Plants supply food, shelter, and protection. Animals pollinate plants and their wastes and dead bodies enrich the soil.

Deciduous Forests of the World



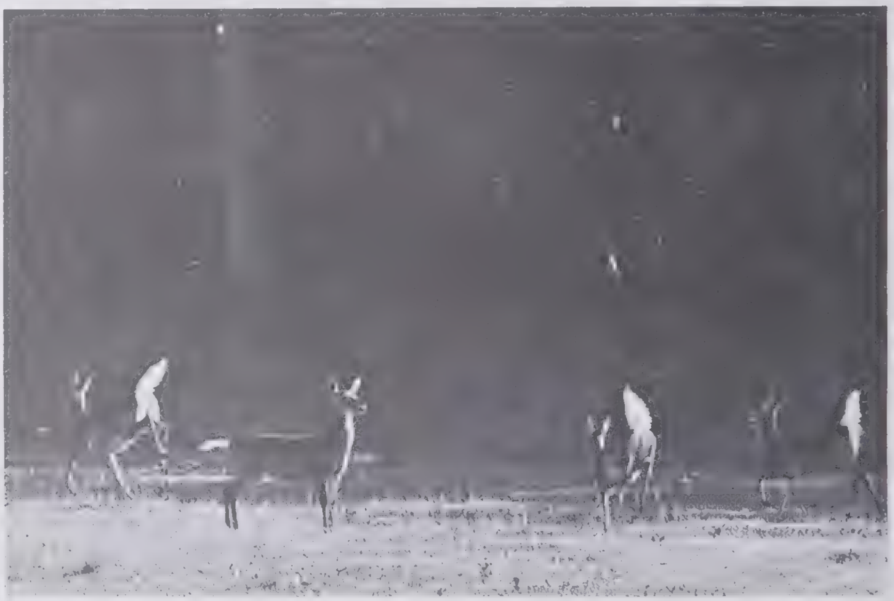
H 94

Red squirrels, like this one, are often crowded out of forests by bigger gray squirrels.

A male hairy woodpecker with his favorite food, an insect.

H 93

Are these male or female white-tailed deer?



Try to find out what prey this garter snake could be hunting.

Raccoons can make their hair stand up so they look bigger to their enemies.

Have you ever seen a live monarch butterfly?

→ H 96

Why have people sometimes destroyed deciduous forests? To use lumber for homes and paper goods.

What happens to the animals when a forest is destroyed? Some die, some may go elsewhere.

Should we try to preserve the rest of our deciduous forests? Explain your answer. Students speculate.

If you live in a large city, what can you do to help save our forests? Become involved in conservation projects.

Research You Can Do

There are other important life zones on Earth, for example the evergreen forest, the rain forest, the grasslands, and the shallow ocean waters. Find out all you can about one of them. One book that might help you is *Nature's Network* by Keith Reid.

Exploration 5. Populations

Overview

The ever-increasing world population and predictions for the years ahead are presented in this activity. The students get most of their information from studying and interpreting a graph on the growth of human population.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) describe or define *population*.

(2) interpret a graph on the growth of human population.

Materials for Each Group

pencils

Hard Cover Folios Preceded by H

Time

Two days

1. Shorten this lesson if your class is not one that enjoys discussions.

2. Your library may have census tracts for your own area. This information may be more interesting to your students than general facts.

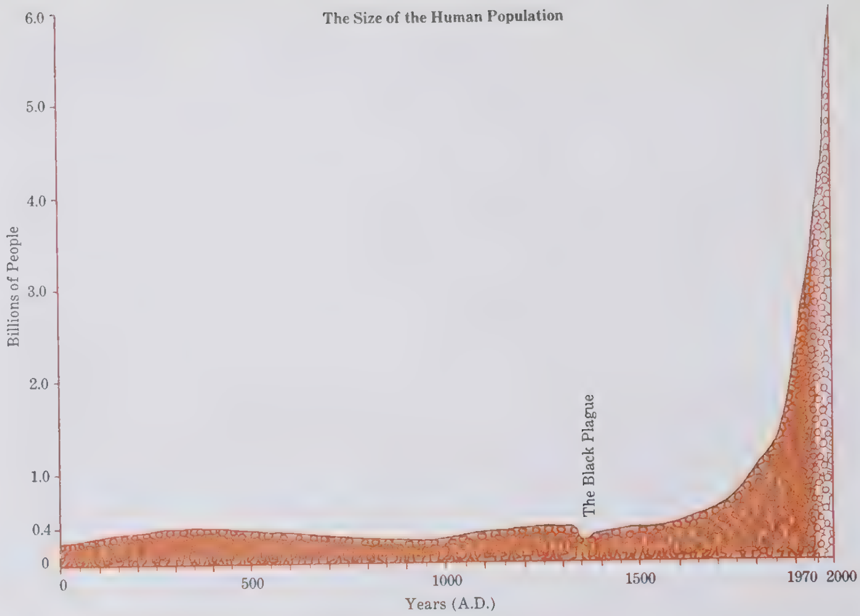
3. If the population of your city has changed, try to analyze why. Use the four reasons why population changes. For example, the death rate goes up or down. Why? People emigrate or immigrate. Why?

5. Populations

A beach full of male fur seals with their harems. Can you tell which ones are the males?

1-2. THE FUR SEALS on a beach. The trees in a forest. The mice in a barn. The roaches in a building. The people in Salt Lake City in 1974. What do all these groups have in common? Each of these groups is a **population** (*pahp yuh LAY shuhn*). A population is made up of all the same kind of living thing in a particular place.

3. Populations change. They can grow, and they can die out. Four things affect the size of a population: the number of individuals that are born, the number that die, the number that move in, and the number that move out.



4. Look at the graph of the human population. What was the population of the world in these years?

1650 **Students interpret graph.**

1750 ____________________

1850 ____________________

1950 ____________________

5. In what years was the world population this big?

1 billion (1,000,000,000) **Interpret graph.**

2 billion (2,000,000,000) ____________

3 billion (3,000,000,000) ____________

4. Use this lesson to point out the problems that may come with the increase in population. Let students make suggestions. Most of them will realize that housing, food, and space would be at a premium.

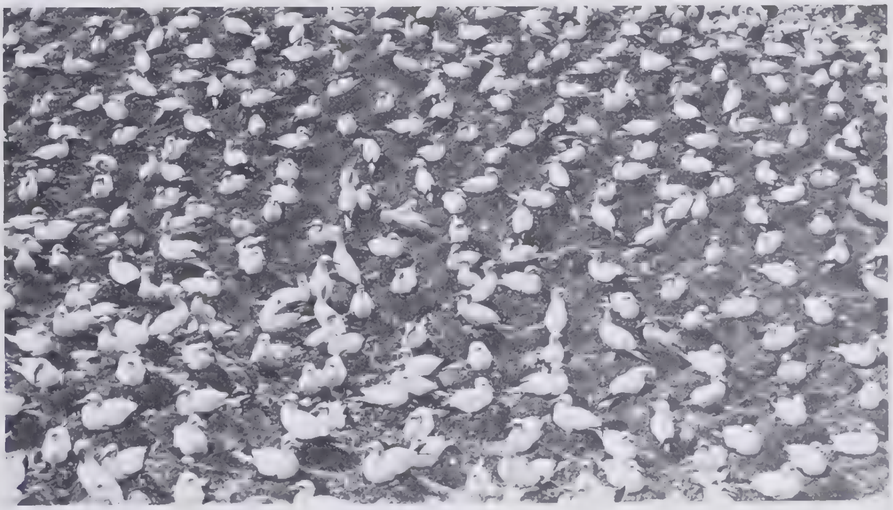
5. BSCS green version has descriptions of experiments on overcrowding that are done with mice.

6. Some of your urban students may live in overcrowded neighborhoods. Explore the idea that crowded conditions may cause stress and antisocial behavior.

6. Can you think of any reasons why the world population is growing faster now than 100 years ago? Improved health conditions, better water supply in some areas, and more food.

The graph has a dark part and a light part. The light part is a prediction. What events could keep the prediction from coming true? Let students speculate.

Try to find a way to estimate the size of this population of gannets. How many birds are there?



←

H 98

7. In what year is the population expected to be more than 6 billion?

Read graph.

How old will you be in that year? Varies.

8. **Research You Can Do**

In the United States, the Bureau of the Census counts the population. Find out how they do it. How often do they make the count? What questions do they ask?

Try to find out how people and animals respond to crowding. One good book on crowding is *The Population Puzzle* by A. H. Drummond, Jr.

7. Have the class suggest ways that the information on the census can be useful. Examples: for planning schools, transportation, shopping areas.

8. If you feel your class can handle it, discuss the theory Malthus developed.

Exploration 6. Sampling a Population

Overview

Most students are familiar with sampling. They may know that television programs are cancelled and elections predicted on the strength of polls. However, they may not understand the mechanics of sampling and an explanation will be necessary. It takes a bit of discussion before the class can recognize what constitutes a good sample. Let the students express their opinions. Some of their ideas show surprising insight. In this Exploration there is a built-in opportunity to concentrate on a school problem. Let students suggest the problem.

Exploration
6. Sampling a Population

A sample of the population of Democrats in 1972. How was this sample chosen?

SUPPOSE you were planning a day care center for children of working mothers. You would need to know how people in the community felt about the plan. Were they for it or against it? How could you find out? One way would be to ask everyone in the community, but that would take a lot of time. An easier way would be to take a sample. You could ask just a few people from each group in the community.

For example, you could ask a sample of working mothers. Tax money would be used to run the center. So you might want to sample all the taxpayers. You might also need to find out how local politicians felt about the center. But you probably wouldn't want to sample children under five or people from the next town.

← H 99

1. Part One Good Samples?

Decide whether each of the following examples is a good way to sample the population. Give a reason for your answer.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) evaluate the usefulness of several sampling techniques.

(2) design a plan for a population study and carry out the plan.

Materials for Each Group

pencils

Time

Three days

1. Part One Students will be familiar with public opinion polls by which election results are predicted and TV programs are rated. The Gallup poll and the Harris poll are examples.

Try to have the students determine the validity of examples in Part One. There may be differences of opinion. Allow the students to express their ideas freely.

During a traffic jam, ask 2,000 commuters for their opinions about mass transit. Let students speculate. Make sure they realize a good sampling question does not stack the deck for or against.

Try to predict who will win an election for mayor in Chicago. Ask for the opinions of over 200,000 people from Maine to California.

Students speculate.

Find out if there are enough day care centers in the city by asking 500 working mothers. Students speculate.

Find out if there is a need for a new magazine on child care. Telephone 10,000 homes during a weekday afternoon. Probably good sample. Women are apt to be home, at least the ones that would have time to read a magazine.

Find out if there is a need for a new magazine for sportsmen. Telephone 10,000 homes during a weekday afternoon. Same as last statement.

Find out how popular a TV program is. Telephone 50,000 homes during the time it's on. First ask if they are watching television. If they are, ask what program they are watching. Same as above.

← H 100

2. Part Two A School Problem

Now work together with your classmates to sample your high school population. First decide on a problem you want to study. Make sure the problem can be studied by getting information from the students in your school. Plan your work carefully. Be sure your sample includes the people who are affected by your problem. Do not question any person more than once.

State the problem you are interested in. Students decide. Students should discuss this until they agree on a question to ask, then make plans for sampling the school.

Write down the questions you will ask. Answers will vary.

2. Part Two Here is a chance to use the sampling technique to study a high school problem. The students should decide what question to ask. Be sure it requires a yes or no answer or an answer that indicates a choice. Some possibilities might be:

Should all students be allowed to take only those courses important to them?
Should students be allowed to leave the building for lunch?
Should there be more assemblies?
Should girls be part of the bowling team?
Should subjects be marked on a pass-fail basis?

What did you find out from your sample? (You may want to put your results in a chart.)

How many students made up your sample? Varies.

How many students are in the whole school population? Varies.

What percent of the population did you study? Varies.

Are there groups of students with different interests in your school?

Yes.

Do you think that your sample gave a true picture of the whole school population? Why do you think so? Student decides. Students might need help with math.

How can you, the school, or the community use this information?

Student decides.

← H 101

1. People have created their own life zones. We call them cities and towns. They are homes for populations of animals, such as people, dogs, cats, rats, sparrows, pigeons, roaches, and flies. Cities and towns also have populations of grass, weeds, and trees.

2. All of these living things respond to each other. They also respond to their city environment of buildings, streets, and parks.

Unlike other life zones, cities and towns can't keep going by themselves. Drinking water, food, and fuel have to be brought from outside. Garbage and body wastes have to be removed.

3. Sometimes, things *do* stop running for a while. The trains break down, or the garbage men go on strike. Then the city begins to bury itself in garbage. Or it starts to run out of food. Or buildings get shut down because there is no heating oil.

← H 102

Reading 7. Environments Are for People, Too

1. The students are experts here. Let them make suggestions and elaborate on the material in the text.
2. If there is interest in city planning, some time may be spent on this topic. The problems of redevelopment, zoning, and living in projects may be very close for students in a large city.
3. When dealing with people, their cultures, habits, and life-styles must be included in the plans that are made.

The animals and plants that live in the cities have other problems, too. The air they breathe is likely to be polluted by gases and dirt from factories, incinerators, cars, and planes. People have some special problems. The strains of living in a city — noise, crime, overcrowding — contribute to mental illnesses.

4-5. Schools and homes are often overcrowded in the city. There are not enough places for people to live. But there may be a lot of unrented offices and parking lots. There are plenty of good jobs. But there are not enough trained people to fill them. At the same time, untrained people cannot find work. There are also many people who work in cities but don't live in them. These people often help to cause the problems of the city.

Life in the city has its good points, too. There is a choice of stores and schools, newspapers, magazines, and movie theaters. There are different kinds of people from different places. There are more doctors and dentists, clinics, and hospitals than elsewhere.

6. Part of the trouble with cities is that we did not just find them and fit into them, the way other livings things fit into their living zones. We did not plan most of our cities, either. They just grew. To make cities better places to live, we'll have to plan them and plan them carefully from now on.

That will not be easy. Human beings are difficult animals to deal with. People have their own ideas and their own dreams. They don't like to be told what to do. But people are going to have to make a lot of new laws, for example, laws about pollution.

7. We have to learn to remember that our human life zones depend on all the other life zones. All of us — plants and animals — have to share the same planet. We can change or destroy another life zone. But our own home will be affected, sooner or later.

A city is a living thing. It can thrive or die.

4. Ask students whether they would rather live in the city or suburb. What are the advantages and disadvantages of living in the city or suburb?

5. Overpopulation is a problem that young people will have to face. Zero population growth might be explained here. Some students may have heard about it.

6. You may wish to show the film "The City as a Human Habitat" by the Holt/Ealing Company.

7. The idea of sharing the planet and not just the city may be new to the class.

Exploration 8. Your Own Community

Overview

In this Exploration the class gets the opportunity to look at their own city or town objectively. They can recognize problems and suggest ways of handling them. They will realize that many problems can be solved only by people working together.

There will be a tendency at first to deride city living. Don't try to soften it until the class is talked out. If some student doesn't start thinking positively, the teacher will have to initiate it. Ask for comments from students that have lived in or visited rural areas.

Exploration
8. Your Own Community

1. THIS LESSON gives you the chance to look at your own community. Use the ideas of everyone in the class as you work on this lesson.

2. How would you describe your community? Varies.

3. How many different populations live in your community? Varies.

What are some of the good things about living in your community?
Varies.

4. Make a list of the problems that you see in your community. You may be able to solve some of these problems by yourself. Some problems can be solved if you work with other people. Some can be solved only if people all over the world are interested. After you list each problem, decide whether you can help solve it. Then think of a way it could be solved.

On the next page there are two examples to help you get started.

← H 104

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) discuss some of the advantages and disadvantages of living in their community.

(2) list some of the local and global problems people face and suggest solutions for some of them.

Materials for Each Group

pencils

Time

Two days

1. The groups should work for about 10 minutes. Encourage them to list as many problems as they can.

2. When the time is up, have one person from each group list the group's problems on the chalkboard, if you wish. There will be some duplication but use this list as the basis for class discussion.

3. An alternative method is for each group to list its problems on a duplicating master. A copy can then be made for each member of the class.

4. The list of advantages and disadvantages of living in the city or suburbs can also be put on the board as a basis for your discussion. You will find duplicate problems in each place—for example, the problem of young people using drugs. Sometimes city youngsters do not realize how universal many of their problems are.

PROBLEM	CAN YOU HELP?	A POSSIBLE SOLUTION
Litter in the streets	yes	Don't be a litter bug.
Pollution from atom bomb test	no	Countries agree to stop testing bombs.

Students add to list.

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 36 or direct students to the Laboratory Supplement.

Part One

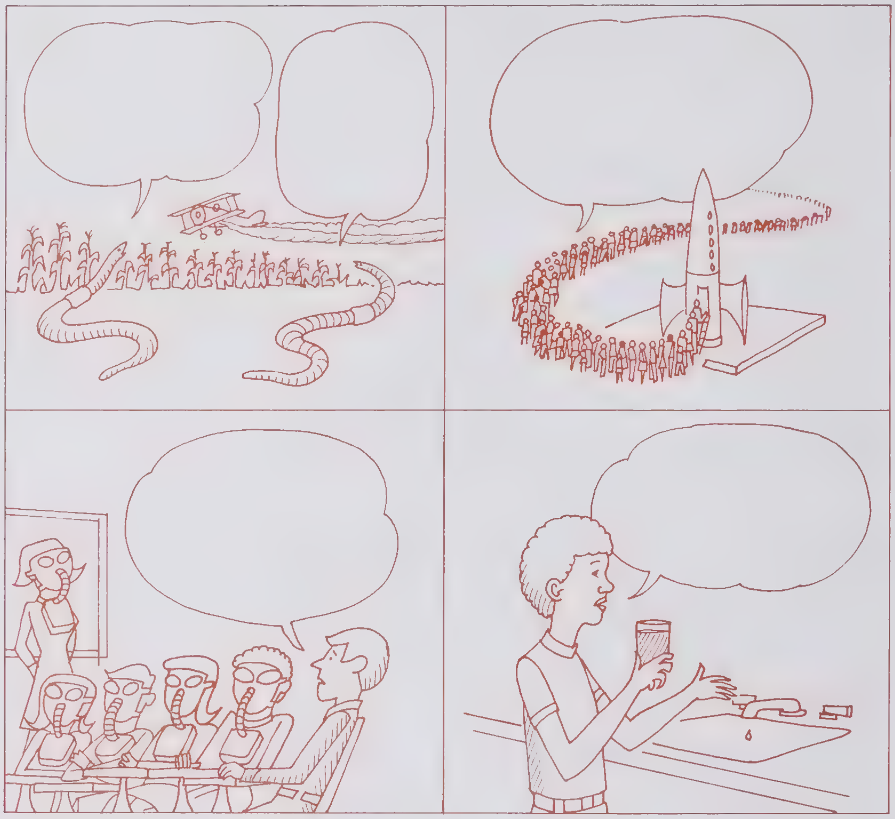
The answer to each question is hidden in the mixed-up letters. Put the letters in the right order and write the answer in the blank spaces. Give yourself ten points for each correct answer.

1. Since plants are the only living things that can produce food, they are called PRODUCERS. (soderpruc)
2. The energy that plants use to make food comes from the SUN. (nus)
3. Plants make food from materials in the ENVIRONMENT. (niverntomen)
4. Bacteria are important in a food web because they are DECOMPOSERS. (serdeosmocp)
5. The chief problem of living in a desert is the lack of WATER. (retaw)
6. The biggest problem in staying alive in the tundra is the COLD. (dolc)
7. A deciduous forest has weather that CHANGES (genachs) from season to season.
8. If the ocean is polluted, the LARGE (ragle) fish may be more dangerous to eat than the others.
9. A group of one kind of living things is called a POPULATION. (toiolunapp)

10. Living in a big city has some disadvantages and some ADVANTAGES. (vantdagaes)

Part Two

USE YOUR WITS to complete these cartoons. What do you think about the environmental mess?



Overview of Unit Two How Living Things Function

The preceding unit gave students experience in using some techniques of scientists. At the same time they acquired biological information. We will continue to follow the same format in this unit.

The microscope, cells, and cell theory are taught in several activities (Chapter 5). Students learn the techniques of using a microscope and making simple slides as they progress from Exploration to Exploration. Allow students as much time as needed to complete their microscope work. Some students may want to do extra work that interests them. You may want to use the activity on the electron microscope to set the stage for diffusion. Diffusion is basic to the physiology activities that follow.

Food getting, food chemistry, and the need for a good diet precede the work on digestion. The Exploration on enzymes emphasizes the chemical nature of digestion. Three pencil exercises help students in thinking and in interpreting information.

The work on the circulatory system includes having students dissect and observe animal hearts. They also record the average pulse rate of their class.

The breathing system leads to a discussion of cellular respiration. There is no attempt to teach detail—just the idea that chemical energy is stored in the body and that it can be released as it is needed. Students identify parts of the breathing system and explain the function of the diaphragm. They also list several sources of air pollution in their neighborhood.

The importance of the kidneys in maintaining homeostasis and the skin's work in making us aware of the outside environment are found in the activities on excretion. Students dissect, observe, and record the function of the kidneys. Measurement with Celsius and Fahrenheit thermometers is introduced too. Students get the opportunity to use both thermometers in their work.

You can refer to the section on human behavior as a background for the work on the nervous system. The activities on the senses are meant to show function, not structure. Students study the four important parts of the brain.

Anatomy and physiology are emphasized especially in the frog dissection. Most students look forward to this activity. Occasionally a student may want no part of it and should be given a substitute assignment. Be sure that the frog dissection is meaningful and is done seriously. Having the students follow the step-by-step directions will eliminate the possibility of careless work.

In this unit there are illustrations that can be used to compare the various systems of some representative animals. The teacher's background and the students' interest will determine how much time will be spent on these diagrams. These same illustrations give you the opportunity to talk about classification and the increasing complexity of animals. You will also have occasion to point out some of the evidence that supports the theory of evolution.

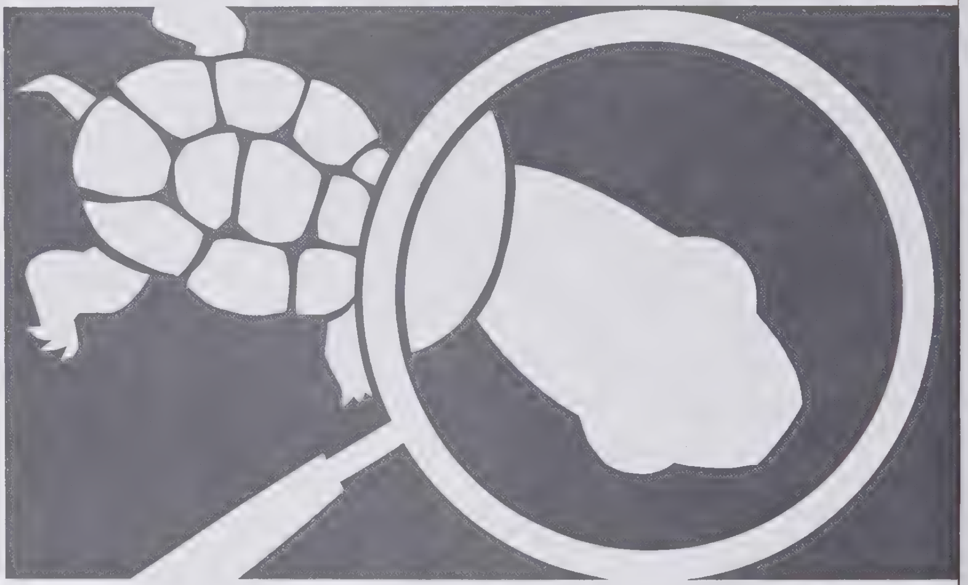
This unit has left out as much traditional biology as it has included. We have purposely introduced the basic biology concepts without stressing facts. If this approach troubles you, add what you wish by using charts, models, and films. Remember that the Explorations are the backbone of the course and are aimed to teach more than the details of subject matter.

→ H 105

Unit Two

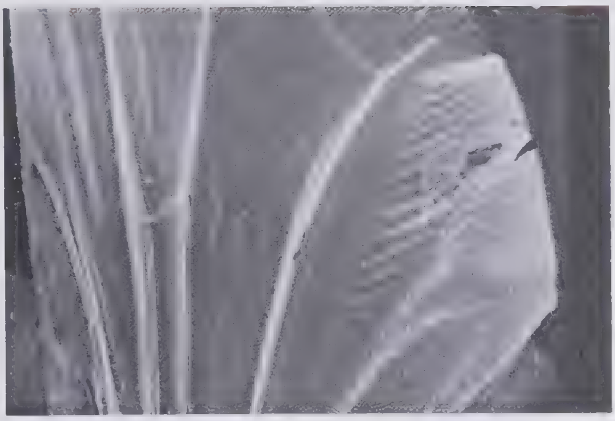
How Living Things Function

5 Cells and Tissues



Reading

1. Seeing the Invisible World



Can you tell what this is a picture of?

1. **There was a time** — about four hundred years ago — when people knew only the world they could see with their eyes. And then something was invented that opened up another world — a world they had never seen. It probably did not seem easy to believe then, and it seems pretty strange even now. It was the world of the **microscope** (*MY kroh skohp*). In the next section, you will learn how to use one.

2. The microscope is one of the most important tools of the biologist. It is a tool that has been improved over the years. Each time it was improved, man was able to see more and more of the world.

There are many different kinds of microscopes. The most powerful are called **electron microscopes**. They can magnify things many thousands of times their real size. You need special training to use one. As a beginner, you will start with the simplest kind of microscope, a magnifying glass that magnifies three or four times. Later, you will work with one that magnifies things 100 to 400 times their normal size. Your school microscope is fairly simple, but it is still much better than the ones the early scientists had. There is a whole new world on the other side of the glass.

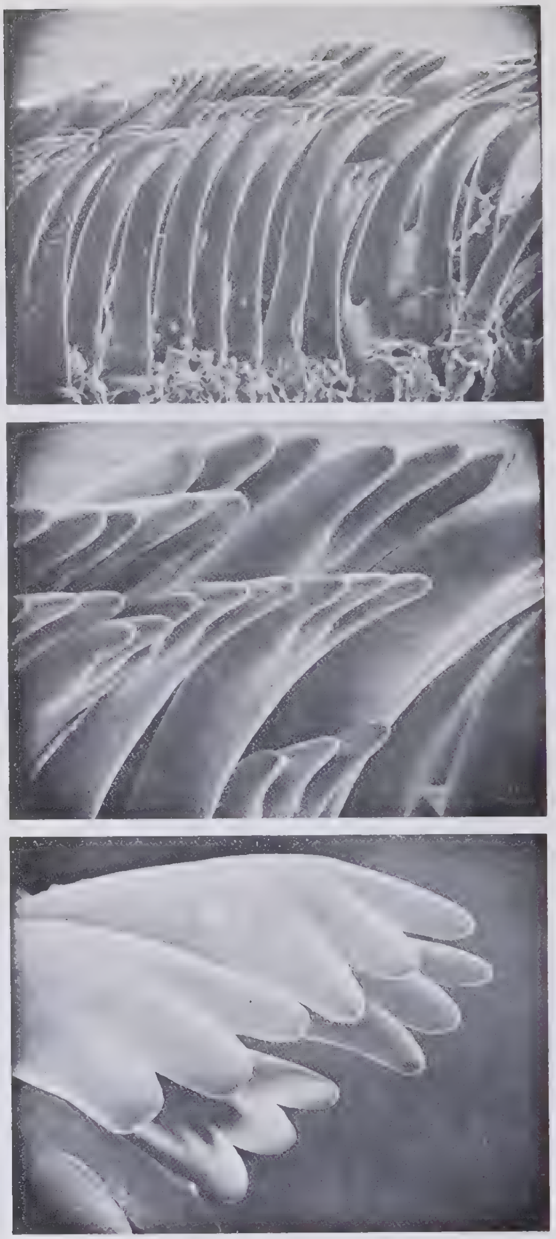
Be sure that when you look, you take the time to really see what is there. If you don't, you will miss a lot of biology and a lot of fun.

Reading 1. Seeing the Invisible World

1. Give a short talk on van Leeuwenhoek and one of his microscopes.

2. Comment on some of the early work done by Galileo, Robert Hooke, and others, using microscopes as a tool. Point out that science has progressed as better tools were invented. At times, progress had to wait for a tool. For example, biologists hypothesized that viruses existed but couldn't see them until the electron microscope was invented.

This small fish uses its teeth to scrape tiny plants off rocks. The pictures on the right show its teeth — magnified about 65 times their normal size, about 135 times, and about 175 times.



Exploration 2. The Simple Microscope

Overview

Here is introductory material to the microscope. The students handle a magnifying lens and learn some of its characteristics. They will understand what is meant by a focus and will hold the lens in a position where the image is upside down. Try to have a lens available for each person.

Students will explore many things with the lens, and since some will work faster than others, you may want to provide extra material for them to observe. This can include butterfly wings, feathers, and different kinds of fibers.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) use a hand lens to observe different objects in focus.

(2) draw and describe the shape of a simple lens.

Materials for Each Group

hand lens
pieces of newspaper and cloth

Time

One day

← H 109

Exploration
2. The Simple Microscope

1. YOU MAY NOT have thought of magnifying glasses as microscopes. But that is what the first microscopes were. With magnifying glasses, like the one you will use today, scientists first took a look at the super-small world.

   Use your magnifying glass to look at your sleeve, your stocking, or some other piece of cloth.

2. Move the **lens** up and down until you get a sharp, clear picture of the cloth. Now the cloth is *in focus*. Describe how it looks.

   Let student express ideas.

   How does the cloth look when you move the lens farther away from it and the cloth is *out of focus*? **Let student express ideas.**

   Use your lens to examine the print on a piece of newspaper. Try to find the place where the print is in focus. Describe how the print looks when it is magnified. **Let student express ideas.**

   Hold your lens up to your eye. Look through it at an object far away. Move the lens away from your eye until the object is in focus. Describe what happens as you do this. **Image is upside down.**

3. Use your magnifying glass to look at other things in the classroom. Then look carefully at the lens. This is the same type of lens that

1. You might want to introduce the lens by having the students make one. Place a drop of water over a pinhole punched in a piece of heavy paper.
2. The objective of this activity is to acquaint the students with what the lens will do and with what is meant by a focus.
3. Don't be concerned about time. One period provides enough time to complete the work of the activity as well as time to play with the lens.

4. you would find in a camera and in your eyes. Draw or describe its shape from the side. (It might help to feel the shape of the lens with your finger.) Lens is thicker in the middle.

4. Each student should have her own lens. If you don't have enough, tap the resources of the physics department and borrow some of theirs.
Reminder: Collect pond water for Exploration 9.

Exploration 3. The Compound Microscope

Overview

Underachievers show skill in handling equipment but, like other students, must be taken through the process of learning the microscope step by step. If this lesson is successful, the teacher will find that the other microscope lessons will move smoothly. However, constant reminders to handle the microscope properly may be necessary for the next two or three days. We found that underachievers do not break more equipment than their college-bound friends, so do not be fearful of having them use microscopes.

It is useful to have some help in supervising this lesson. Students will run ahead of you and will try to look

Exploration
3. The Compound Microscope

← H 110

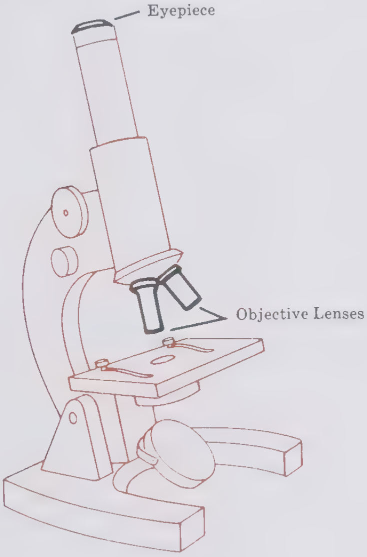
Soon after the first microscope was invented, somebody thought
1-2. of using two lenses working together. Two lenses give a much greater magnification than just one.

This kind of microscope is called a **compound microscope**. The microscope you will be using today is a compound microscope.

3. Part One How Much Magnification?

The lenses of your microscope have different names. The lens at the top of the tube, the one you look through, is called the **eyepiece lens**. The other lenses are called **objective** (*ahb JEHK tihv*) **lenses**.

You can see that there is more than one objective lens on your microscope. Some compound microscopes have two objectives, some have three or more. Each objective gives a different magnification when it is used with the eyepiece lens.



at pencils, fingers, rings, or hair. You will appreciate the assistance of a colleague or an older student. When students learn that they can't see a finger or a ring, they will be more willing to master the technique of proper microscope use.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) name the parts of a compound microscope.

Materials for Each Group

microscopes

Time

Two days

1. Use as many microscopes as are available.

2. In this activity, drill the class in the parts of the microscope. It is important to do this slowly and with care. If possible, have another teacher, an aide, or an older student assist you. One period is needed.

3. **Part One** Have students point to the eyepiece lens and objective lens of the microscope as you name them.

→ H 111

You can work out what the total magnification is like this:

1. There is a number marked on the eyepiece. Usually it has an X beside it. Write the number here. ______________
2. Write the number on the low power objective. __________
3. Multiply the two numbers together. ______________
4. Now work out the magnification of the microscope with the high power objective in place, in the same way.

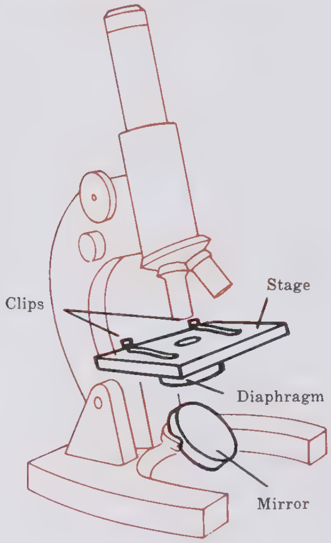
   Eyepiece no. ___ × Objective no. ___ = Magnification ___

Answers depend on microscopes used.

4. Part Two Where Does the Light Come From?

When you look at an object through the microscope, you have to hold the object steady, and you need plenty of light.

The **stage** of the microscope holds things steady. It has a pair of **clips** that can be used to hold a slide in place. Look at the picture. Can you find the stage and the clips? Yes.



4. Part Two Have students point to and name the clips, stage, mirror, and diaphragm of the microscope.

5. Part Three Students may need help in focusing with coarse adjustment and fine adjustment.

The **mirror** reflects light up to the lenses of the microscope. It can be turned in any direction to give the most light. Look at the picture again. Can you find the mirror? Yes.

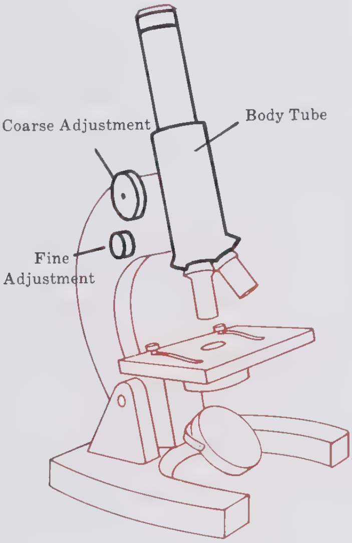
There is a hole in the middle of the stage just above the mirror. This hole can be made bigger or smaller by opening or closing the **diaphragm** (*DY uh fram*). The diaphragm helps you get just the right amount of light so you can see clearly. Can you find the diaphragm in the picture of the microscope? Yes.

Now find the stage, the mirror, and the diaphragm on your compound microscope. Your teacher will show you how they work.

5. Part Three Getting Adjusted

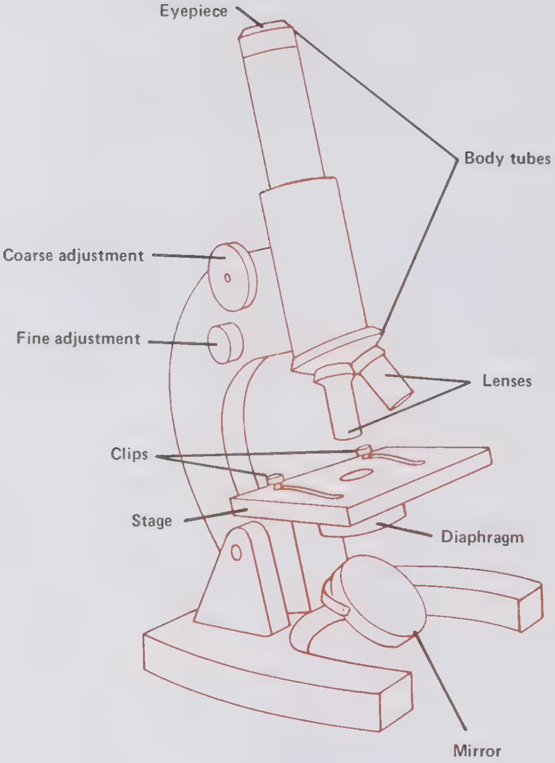
← H 112

On each side of your microscope there are two knobs or wheels. The large knob is called the **coarse adjustment**. The smaller knob is called the **fine adjustment**. The adjustments move the body tube up or down. You use them to get a focus, just as your hand moved the magnifying glass to get a focus. Can you find the coarse and the fine adjustment on your microscope? Yes.



Hard cover users: To reproduce the illustration of the microscope for this Exploration please turn to page T 59 or direct students to the Laboratory Supplement.

Each black line in the drawing points to a part of the microscope. Write the name of the part next to each line.



170 *Cells and Tissues*

Exploration 4. Getting a Focus

Overview

This is a practice session to develop skill in handling microscopes. To minimize possible damage, no slides are used. Again, another supervisor in the room will make it possible to help students that need it.

A review of the parts of the microscope will be needed. Students will tend to run ahead of the activity and try to look at opaque materials. Some students will move along faster than others, so have a large assortment of materials for them to look at. Since this Exploration is presented without using slides, select material that will lend itself to being placed on the stage without support.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) demonstrate the use of the coarse adjustment and fine adjustment of a compound microscope.

(2) observe objects using both low and high power objectives.

Materials for Each Group

microscopes
lens paper
assortment of thin flat objects such as cloth and nylon stockings

Exploration

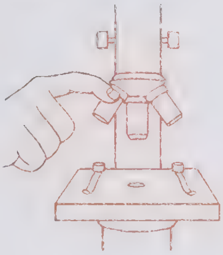
4. Getting a Focus

← H 113

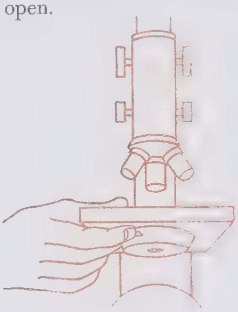
1. TODAY YOU are going to learn how to get a focus with the compound microscope. You will do certain things every time you use the microscope. It costs a lot to repair a microscope. If you do not follow the steps, you may damage it. Remember: NEVER LEAVE OUT ANY OF THESE STEPS. ALWAYS FOLLOW THEM IN THE SAME ORDER.

2. Place a (√) in front of each number after you have followed the instruction.

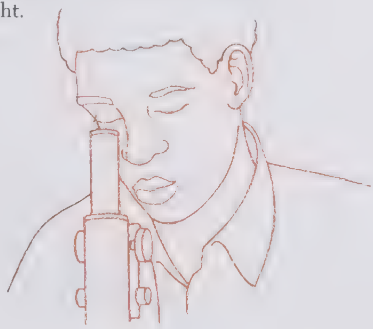
( )1. Move the low power objective into position. You should hear a click when it is in place.



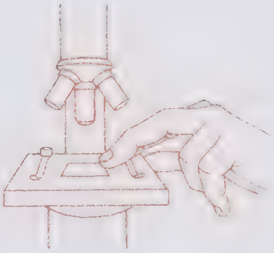
( )2. Make sure that the diaphragm is wide open.



3. ( )3. Look into the eyepiece. Move the mirror until you see a bright circle of light.



( )4. Place a piece of lens paper, cloth, or nylon stocking over the opening in the stage.

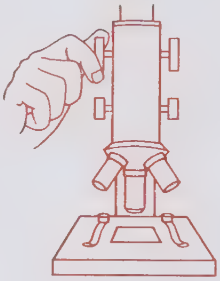


Time

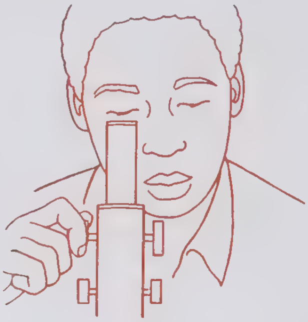
Two days

1. Use as many microscopes as you can.
2. Start this activity by reviewing the parts of the microscope. This will help to bring up to date any student who was absent
3. Lens paper is good to start with

( )5. Watch from the side while you turn the coarse adjustment *away* from you until the low power objective is about 1 centimeter above the stage. Turn the adjustment slowly and carefully. (Some microscopes will lock before you get too close to the stage.)



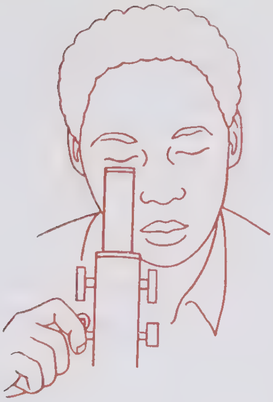
( )6. Put your eye to the eyepiece. Turn the coarse adjustment *toward* you until you get a focus. Always focus by moving the eyepiece upward. If you focus by moving it down, you may damage the objective by hitting the stage.



Draw a picture of what you see.

DO NOT DISTURB THE FOCUS. Now watch from the side and turn the high power objective into place. Notice that the lens is very close to the object on the stage.

Put your eye to the eyepiece. You should still have a focus. If you don't, or if you want to get a sharper focus, use the fine adjustment, as shown on the next page.



Why do you think you use the fine adjustment rather than the coarse adjustment? ______________________

____

____

← **H 115**

4. Draw a picture of what you see with the high power objective.

5. Try looking at as many different things as you have time for. Draw a picture of each thing as it looks through the low power objective. Then draw how it looks through the high power objective. Label each picture with the name of the thing you were looking at.

4. The object must be kept flat to get a good high power focus. Make several materials available and let the students choose what they want to look at. Pieces of cloth, stocking, netting, cheesecloth, and paper might be included.

5. This part of the lesson may not be completed within the period. Don't be concerned with time. Let the students do what they can.

REMEMBER: every time you put something new on the stage, follow the steps you learned in this lesson.

It is a good idea to train yourself to look through the microscope without shutting one eye. You will get used to seeing what you want to see. And you won't feel as much strain. Also, you will be working like a scientist, not a beginner.

Check Yourself

1. When is it better to use the high power objective? **When the object is very small or when you want a larger magnification.**

2. When would the high power objective not be useful? **When the object is seen clearly under low power.**

3. List some of the things that could not have been discovered until the microscope was invented. **Blood cells, bacteria, viruses, structure of parts of living things, structure of materials.**

Exploration 5. Making Slides

Overview

Perhaps the students realize that material has to be prepared for viewing with a microscope. They will learn the technique of making simple temporary slides and will be limited only by the material they find in the room or on their person. Built into this activity is an understanding of depth of focus and the fact that the microscope inverts the image. Careful work and careful observations are necessary. A good foundation in microscopy should have been gained from previous Explorations. You may have to work separately with absentees who missed the last two lessons as they are not ready to tackle this one without some basic information. The students should know the parts of the microscope, how to adjust the mirror to get the best light, how to place material on the microscope, and how to get a focus. You may need to take a few minutes of the period for review.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) make a wet mount.
(2) mount the slide on the stage of a microscope.
(3) record their observations of the wet mount.

Materials for Each Group

microscopes
4 slides (plain)

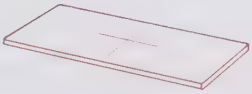
Exploration
5. Making Slides

1. You can see things better under a microscope if you put them on slides. Today, you will learn how to make slides.

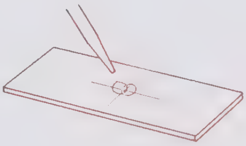
Follow the steps for getting your microscope ready. Put the low power objective in place, open the diaphragm, and get a clear circle of light.

Put a (√) before each number after you have followed the instruction.

( ) 1. Place two hairs on a clean glass slide. Cross one over the other. You might try using two different kinds of hair. They could be two different colors or different thicknesses. Or you could use hairs from different animals.

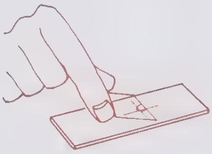


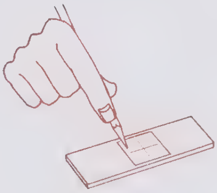
( ) 2. Put one or two drops of water on the hairs where they cross.



← H 116

( ) 3. Pick up a **coverslip** very carefully by the edges. Put one edge of the coverslip right next to the drop of water on the slide. Now lower the coverslip very slowly. The water should spread out underneath it.





2. ( ) 4. Press the coverslip gently with the tip of a pencil to get out any small air bubbles trapped underneath it.

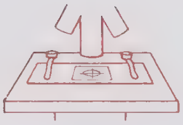
4 coverslips
assortment of materials: human hair, feathers, thread, tissue, silk, wool, butterflly wing, parts of insect body
dropper
scissors

Time

Two days

1. In making slides, care is needed to avoid breakage.

2. Many students will mistake air bubbles for what they are supposed to see.



3. ( ) 5. Place the slide on the stage of your microscope. Make sure that the place where the hairs cross is right over the opening in the stage. Hold the slide in place with the clips.

( ) 6. Focus on the hairs. (Remember how you did this in the last lesson? If you don't, get out the last lesson and take another look.)

( ) 7. Look through the eyepiece. Move the slide until you find the place where the hairs cross.

4. Are both hairs in focus? No.

How can you explain this? One hair is closer to the eye so they are not in perfect focus at the same time.

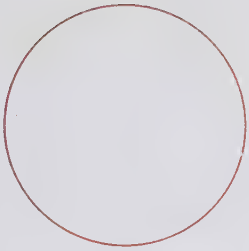
Describe any differences between the two hairs. Varies.

If you like, you can put the high power objective in place. Write down what you see now. Hairs thicker and difference in focus is more obvious.

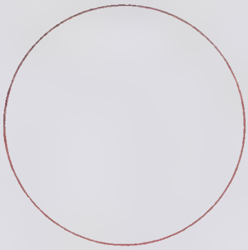
5. Make another slide the same way you made the hair slide. Try using something else. You might look at a small piece of feather, thread, cloth, tissue paper, an insect wing, or a fly's leg. Whatever you use, follow all the steps.

Look at your new slide with the low power objective in place, and then with the high power objective. Draw what you see in the space at the top of the next page.

3. Don't be concerned about time. Let the students make as many slides as they can.
4. Use hairs from members of the class. A gray hair makes an interesting contrast to a more youthful color.
5. Feathers or butterfly wings are interesting to study, although any of the suggested materials will intrigue the students.



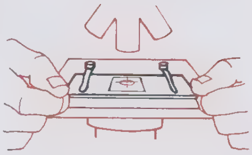
Low power



High power

← H 117

While you are looking into the microscope, move the slide slowly away from you. The best way to do this is to place your thumbs on each end of the slide and push carefully.



What seems to happen? The slide moves toward me.

Now move the slide slowly to your right. What seems to happen?

It moves to the left.

What does this tell you about the way things seem to move under the microscope? Opposite to actual direction.

Does this remind you of something that happened with the magnifying glass? What was it? The image was upside down.

How can you test to find out if the object is right side up when you view it under the microscope? Use an object with a definite top and bottom. Example, a printed letter in a newspaper.

Check Yourself

Make a list of the things you have learned about the microscope.

Summarize information from the first five lessons.

Exploration 6. Some Plant Cells

Overview

We are beginning to build a major biological concept, that all living things are made of cells. Tissues are an aggregate of cells. Cork and onion cells are easy to study. Students can observe the contrast in size and shape of the cork and onion cells. They can also compare living cells with dead ones. The use of a stain is introduced in a way that makes it easy to see the advantages of this technique. Cells are like boxes and can contain material. Try to get the students to arrive at this conclusion. Encourage them to use the fine adjustment on the microscope.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) describe or define what a *cell* is.

(2) observe the cells of cork and onion under a microscope and draw what they see.

(3) compare the cells of the cork and the onion.

Materials for Each Group

thin slices of cork
stain (iodine or methylene blue)
pieces of raw onion
pipettes (medicine droppers)

Exploration
6. Some Plant Cells

1-2. Today you are going to use your microscope to look at small pieces of plants. You will be able to see the tiny parts that make up plants and other living things. These parts are called **cells**.

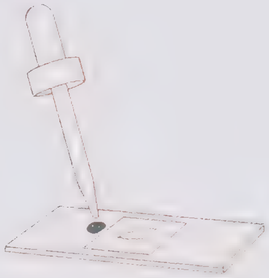
3. Part One Looking at Cork Cells

Cork comes from a plant. It is made from the bark of a kind of oak tree. Make a slide with a very thin slice of cork in a drop of water. Add a coverslip. Look at the slide under the low power objective.

4. Draw a few of your cork cells in this space.

5. You can usually see things more clearly under the microscope if you stain them. Here is how you stain your cork cells. Put a (√) in front of each direction after you have done it.

( ) 1. Take the slide off the stage and put it down flat on your desk or table. Do not take off the coverslip.
( ) 2. Put a drop of stain on the slide, just at the edge of the coverslip.



← H 118

( ) 3. Touch the opposite edge of the coverslip with a small piece of paper towel. This will soak up the water and pull the stain underneath the coverslip.
( ) 4. Put the stained slide back on the stage and look at it under the low power objective. Can you see the cells better now?

2 slides
2 coverslips
microscope
paper towel
water

Time

Two days

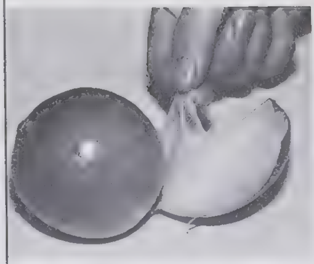
1. Use as many microscopes as are available.

2. The idea of the cell as a unit of structure is the objective of this activity. You are showing that parts of two plants are made of cells. You are not showing that all parts of all plants are made of cells. Some student may comment on this.

3. **Part One** Have slices of cork ready for the students. Use a single-edged razor blade and cut as thin a slice as possible on a slight slant. The thin edge will give the best view under the microscope.

4. Remind the students to draw a few cells carefully. They have a tendency to try to draw too much.

5. The use of a stain to make cells easier to observe is introduced.



6. Part Two Are Onion Cells Like Cork Cells?

In between the layers of an onion, there is a thin skin. Peel off a small piece of it. Put it on a slide and add a drop of water and a coverslip. Look at the slide under your low power objective.

Draw a few of your onion cells in this space.

7. Compare the drawing of onion cells with the drawing you made of cork cells. Write down the ways that they are alike and the ways they are different. **Let students record what they see.**

Take the slide off the microscope. Add stain in the same way you did with your cork slide. Then put the stained slide back on the microscope and look at it under the low power lens.

Do you see anything new? Add any new things you see to your drawing.

Why can you see some things you didn't see before? **The iodine stains some parts.**

Did the stain work in the same way with your cork cells? Can you give a reason? **No. The cork cells were empty.**

6. Part Two Separate the sections of an onion. Have the students pull the membrane from the concave surface of each section.

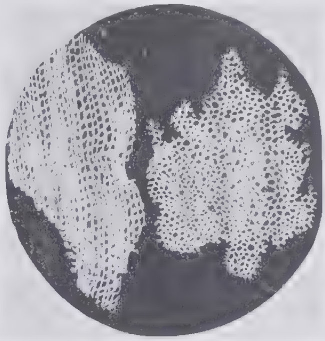
7. Point out to students that the onion is alive.

Check Yourself

1. Robert Hooke was a biologist who had one of the first compound microscopes. He looked at pieces of cork under his microscopes and saw that cork was made up of cells. In fact, he was the man who gave cells their name. This happened in 1665.

   How long ago was that? Over three hundred years ago.

   If you had been Robert Hooke, what would you have called cells? ______



Robert Hooke's careful drawings of cells

2. What is a cell? Let students speculate. Try to get them to note that it is a box or container.

3. When you looked at the cork cells, were you looking at living cells? No. Why do you think so? The cork cells were empty.

4. When you looked at the onion cells before you stained them, were you looking at living cells? Yes. Why do you think so? The cells have contents. They may even show some movement.

5. When you looked at the stained onion cells, were you looking at living cells? No. Why do you think so? The chemicals in the stain kill them.

6. How does staining a slide help you? It helps you see structures that don't show up otherwise.

7. When would it not be helpful to stain a slide? When you want to study living cells.

8. Cells are made up of different parts. You have seen some of them already. The outside of your plant cell is called the **cell wall.** Just inside of the cell wall is another layer called the **cell membrane**. Somewhere near the middle of the cell, you will see a dark, round blob. This is the **nucleus** (*NOO klee uhs*). The nucleus is the cell's control center. The nucleus floats in a thin jelly called **cytoplasm** (*SY toh plaz uhm*). Cytoplasm fills the whole living cell. Try to find these parts on your drawing of onion cells. Label them on the drawing by putting a line to the part and writing its name outside. You might like to color in the cytoplasm.

Exploration 7. Colors in Plant Cells

Overview

In this Exploration the students will be able to add to their understanding of a typical plant cell. Remind the students that when they studied the food chain they learned that green plants were the food makers. They can now see chloroplasts containing this important green pigment.

Looking at the red pigment in the cells of a tomato, you can point out that there are other plant pigments. This will reinforce the idea that a cell is like a box or container.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) observe the cells of an Elodea plant under a microscope and draw what they see.

(2) identify chloroplasts.

Materials for Each Group

microscopes
pipettes (medicine droppers)
piece of tomato
Elodea leaf

Exploration
7. Colors in Plant Cells

A tomato plant

FLOWERS AND LEAVES come in many different colors. Beets, carrots, and tomatoes are all brightly colored plants. Today, you will look at some plant cells and find the parts that give plants their colors.

1. Peel off a piece of tomato skin and make a slide with it. Look at your tomato slide under the low power objective.

You should be able to see the parts of the tomato cells that give the tomato its red color. Draw a few of the cells in this space. Make sure you include some of the colored parts.

2. There may be some parts of the cells that you can't see at the moment. How could you make them visible? **Staining or higher magnification.**

Your teacher will give you a leaf from a water plant called **elodea** (*eh loh DEE uh*). Make a slide with the leaf and look at it under the low power objective.

Draw a few of the cells in this space. Can you see any colored parts in your cells? If so, add them to your drawing.

Elodea

Sometimes you can see these green parts moving inside the cells. Look at your cells for a few minutes and see if you can catch them moving. Can you suggest how these parts move about? **The cytoplasm flows and carries these green parts.**

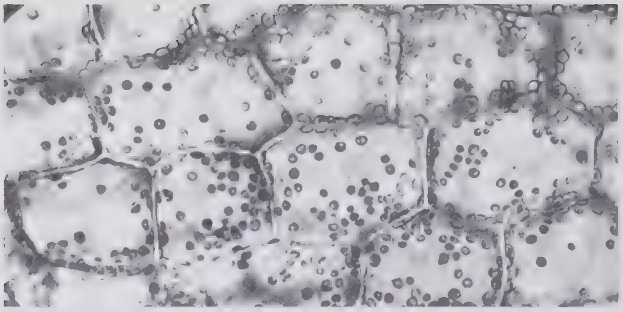
1 slide
1 coverslip

Time

Two days

1. Some students may want to view the tomato pulp under the microscope.

2. Students can usually see chloroplasts move after the slide has been standing for a while, especially if it is in a warm (not hot) place.



Chloroplasts in elodea cells

The green-colored parts of plant cells are called **chloroplasts** (*KLOHR oh* PLASTS). They contain chlorophyll. Chloroplasts help plants make their own food. What parts of a plant usually have cells with chloroplasts? **Leaves, sometimes stems.**

Check Yourself

1. Think up a plant cell of your own and draw it in the space below. It should have all of these parts: *Cell Wall, Cell Membrane, Nucleus, Cytoplasm, Chloroplasts* (you can use different colors).

2. You saw that a small piece of tomato or elodea leaf is made of many cells. If you could put a whole tomato or elodea under the microscope, what would it look like? **You'd expect the whole thing to be made of cells.**

Exploration 8. Some Animal Cells

Overview

Human cheek cells and frog skin are used as examples of animal cells. Observation of their similarities will reinforce acceptance of the cell theory. Students observe animal cells are not very different from plant cells.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) draw a diagram of a typical animal cell.
(2) explain the similarities and differences between plant and animal cells.

Materials for Each Group

microscope
toothpick
dropper
pipettes (medicine droppers)
frog skin (living frog)
iodine
4 slides
4 coverslips
assortment of permanent slides of animal cells

Time

Two days

Exploration
8. Some Animal Cells

H 121

1-3. TODAY YOU will be looking at some animal cells. In many ways, animal cells are like plant cells. For instance, an animal cell has a nucleus, and it is filled with cytoplasm. It also has a thin membrane on the outside.

But in some ways an animal cell is very different from a plant cell. It does not have a thick cell wall. Animal cells do not have chloroplasts, either. This means that animals cannot make their own food as plants do.

To get their energy, animals have to eat plants or eat other animals that have eaten plants.

Note. Page 122 and 123 correspond to soft cover pages 188 and 189.

4. Part One Cheek Cells

The easiest way to get animal cells is to take them from the soft lining of your own cheek, inside your mouth.

Place a drop of iodine on a slide. Use the blunt end of a toothpick to gently scrape the inside lining of your cheek. Don't dig the toothpick in so hard you cut your cheek. Stir the scrapings into the iodine on your slide. Then finish making the slide and look at it under the low power objective.

Try to find some of the cells and draw two or three in this space. Label the membrane, the nucleus, and the cytoplasm of each cell you have drawn.

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1. Use as many microscopes as are available.
2. Remind students to draw just a few cells carefully and to give each cell a shape.
3. This activity does not prove that all animals are made of cells but will be the basis for that generalization.
4. Part One Emphasize that the students should not dig into their cheeks. Just rub gently the inside of the mouth with the toothpick.

5. Part Two Frog Skin

Frogs are always shedding the outside layer of their skins. You can often find bits of skin floating in the water where a frog has been sitting.

6. Make a slide with a small piece of frog skin. Add either a blue stain or iodine and look at the slide under the low power objective of your microscope. Then look at it under the high power objective.

Draw a few of the cells in this space. Label the membrane, the nucleus, and the cytoplasm.

How did it help to stain the frog skin? **It made some parts visible.**

How could you show that it was better to stain your slide? **By looking at an unstained slide and comparing.**

5. Part Two The thin tissue can be gently rubbed off the frog. The trick is to keep the tissue as flat as possible on the slide.

6. A prepared slide of frog skin, frog blood, or any other animal cells may be used as a substitute if a living frog is not in the classroom.

7. Part Three A variety of permanent slides should be available so each student can choose two. Human blood, frog blood, sperms, muscle, retina, and frog skin showing chromatophores are a few suggestions.

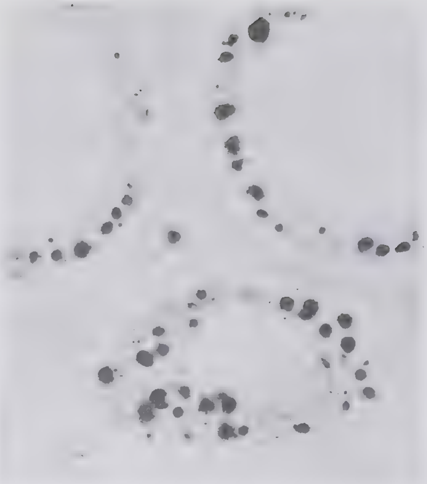
7. Part Three Other Animal Cells

The slides you have been making are called temporary slides, because you can only use them once. (Can you say why?) There is another kind of slide called a permanent slide. It can be used over and over again. Usually, you buy permanent slides from a laboratory or supply house. You will use permanent slides in this part of the lesson. Handle them carefully because they are expensive.

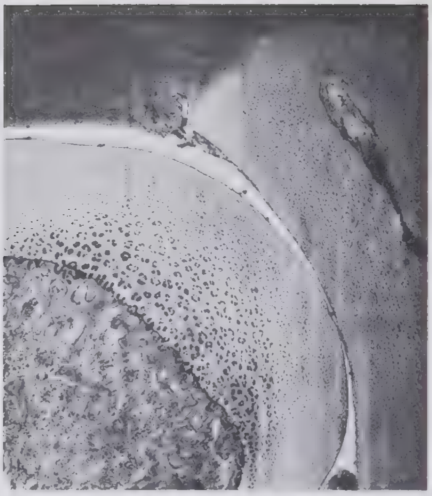
On the front desk you will find some permanent slides with animal cells. Choose any two slides to work with. Look at them under the low power objective. Draw a few cells from each in this space. Label all the parts you know.

How are the cells from your two slides alike? Answers will vary.

How are they different? Answers will vary.

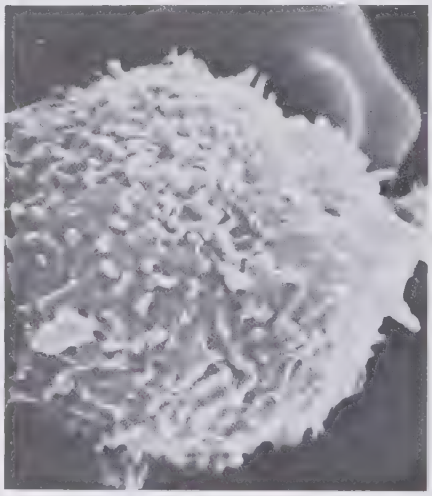


Human fat cells. × *150*

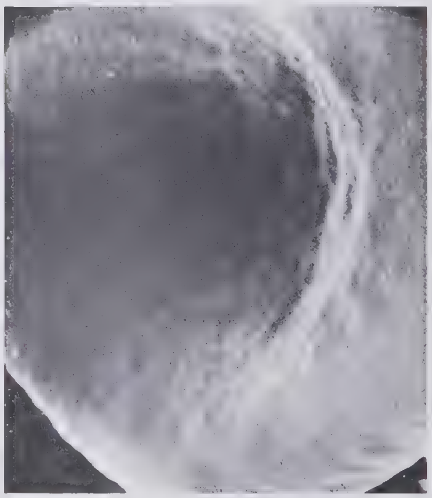


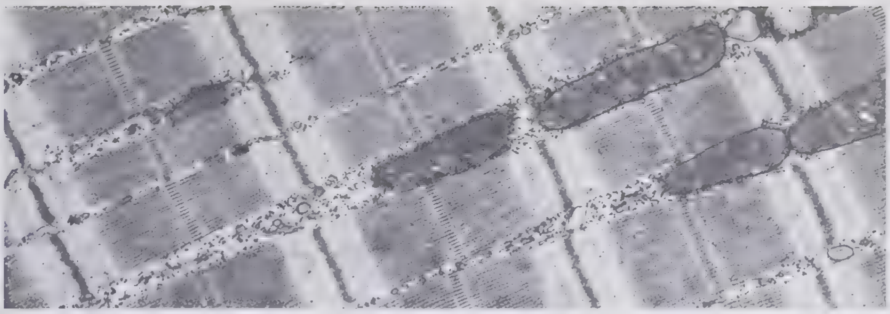
A cross section of an unborn baby's knuckle. × *45*

One kind of white blood cell. × *18,000*

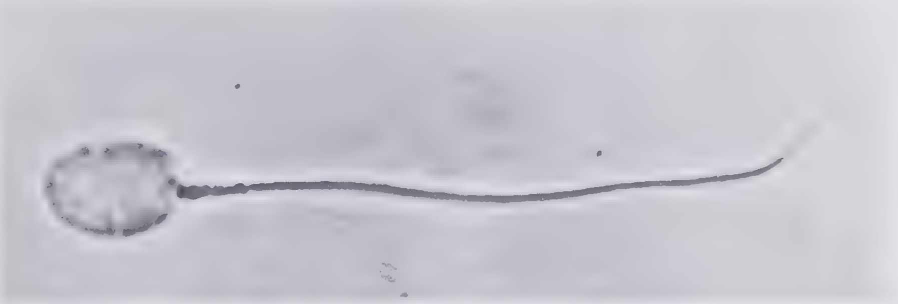


A human red blood cell. × *26,000*

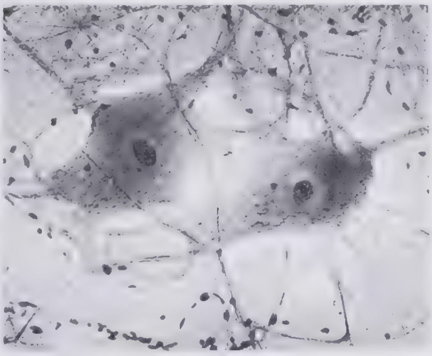




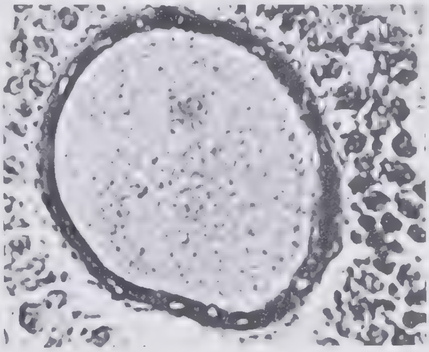
A section through a muscle cell. × 20,000



(Above) *A human sperm.* × 6000. (Bottom left) *Nerve cells.*
(Bottom right) *A human egg cell.* × 75



Courtesy of the Carolina Biological Supply Company



Check Yourself

1. Think up an animal cell of your own and draw it in the space below. Label the membrane, the nucleus, and the cytoplasm.

2. How is this drawing different from the drawing you made of an imaginary plant cell? It has no cell wall and no chloroplasts.

3. Would it be true to say that cells are like small boxes full of living material? How can you tell? Yes, because there are structures inside the cells and all parts are not in focus at once.

→ H 125

4. Cells have many parts that you can't see with your microscope, even with the high power objective. Can you think of any ways you could get to see them? Use higher magnification and try different stains.

Exploration 9. Living Cells in Pond Water

Overview

You have planned ahead for this activity by collecting and maintaining a mixed culture of microorganisms in pond water. The culture should be rich enough to insure that each drop has several organisms in it. With some luck, the students will be able to observe a variety of organisms that will show various kinds of movement. It may be possible to see organisms feeding.

Mention the fact that these organisms carry on the same basic life functions as ants or birds or us. Remind them of the first day of school when they struggled with a definition of life. If you wish to do some taxonomy, ask the class if it can separate these organisms into plants and animals.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) observe organisms in pond water under a low power objective.

Materials for Each Group

microscope
culture of pond water
4 or 6 slides
4 or 6 coverslips
pipettes (medicine droppers)

Time

Two days

Exploration

9. Living Cells in Pond Water

1-3. Many living things are made up of just one cell. These organisms must do all the things that other living things do. They must take in food and oxygen, get rid of waste, move, and reproduce themselves. They must also be able to respond to their environment. Today, you may have a chance to see some of these tiny living things carry on some of their activities.

Your teacher has been keeping some pond water in a jar for a few days. Make a slide with a drop or two of this water. Then look at it under the low power objective.

List all the things you see happening. Let students record observations.

If you see any of the one-celled living things, draw them in this space.

If there is time, make one or two more slides. Use water from different parts of the jar. For example, make one slide with water from the top of the jar and another slide with water from the bottom.

1. The culture should be a mixed one that was started from a hay infusion (allow two-three weeks for growth) or that was collected from a pond, stream, or fish tank and allowed to stand for a few days.
2. Check to be sure that there is plenty of life in the culture before starting this activity.
3. Cultures can be purchased but it is more fun to grow your own. When making slides, try to pick up a bit of scum or debris with your drop of water.

Some of the living things you saw may be made of more than one cell. How could you tell if they were? They are if you see cell membranes dividing the organism into parts.

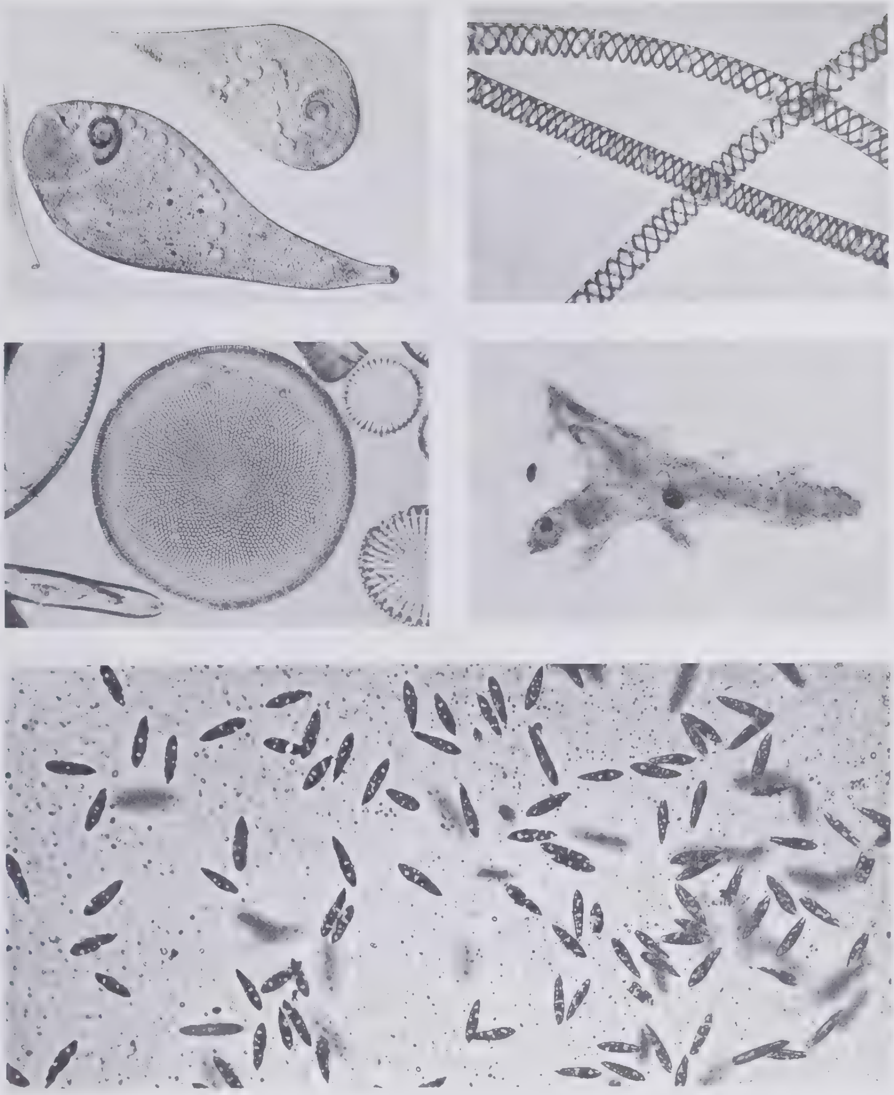
How can you tell which are animals and which are plants? Look for chloroplasts to identify plants.

Check Yourself

1. Almost every pond has these one-celled living things in it. What part do they play in the life of a pond? They supply food for small water creatures. Plants supply oxygen.

2. Make a food chain that includes some of these small living things you have seen. Let students speculate.

3. List all of the facts you have discovered about cells in the last few lessons. Let students summarize.



Courtesy of the Carolina Biological Supply Company

Some common one-celled plants and animals

UNIVERSITY OF ALBERTA

H 127

4. Over 100 years ago, two men suggested that all living things were made of cells. Do you agree? Yes, but I can't prove it.

Research You Can Do

Plan an experiment to show that one-celled living things respond to changes in their environment. List the materials you will need for your experiment.

Exploration 10. Cells Under the Electron Microscope

Overview

This is a pencil exercise on the electron microscope. We are not interested in cell structure but hope that the students will recognize the nucleus, cytoplasm, and cell membrane in the diagram they will be using. Since the physiology materials stress the cell as the unit of function, it is important for the class to understand the structure of cell membranes. Here, again, you can point out that without the invention of the electron microscope much biology would not be known. For example, the study of viruses would be impossible. The class can hypothesize about cell structure as well as about the movement of materials in and out of the cell.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) describe one or more advantages of using an electron microscope.

Materials for Each Group

pencils

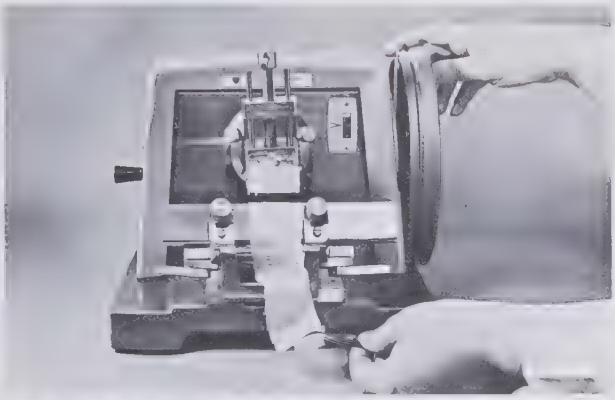
Time

One day

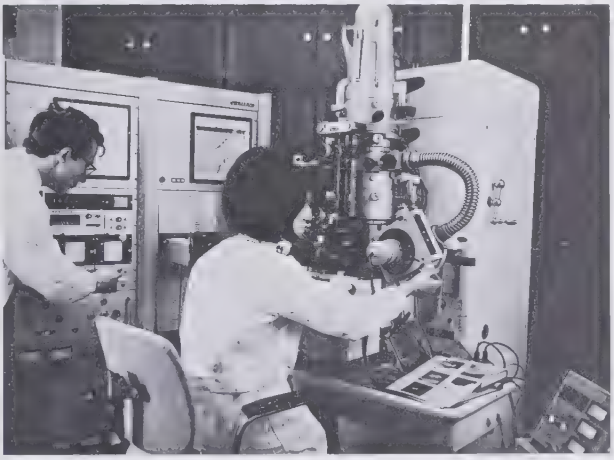
1. Do not require students to memorize parts.
2. It is important that the students realize that a cell is not as simple as it would seem under the light microscope.

Exploration

10. Cells Under the Electron Microscope



An electron microscope can magnify things 200,000 times their normal size. But before cells can be looked at under an electron microscope, they have to be sliced into thin layers. You can't get thinner slices than this machine makes!



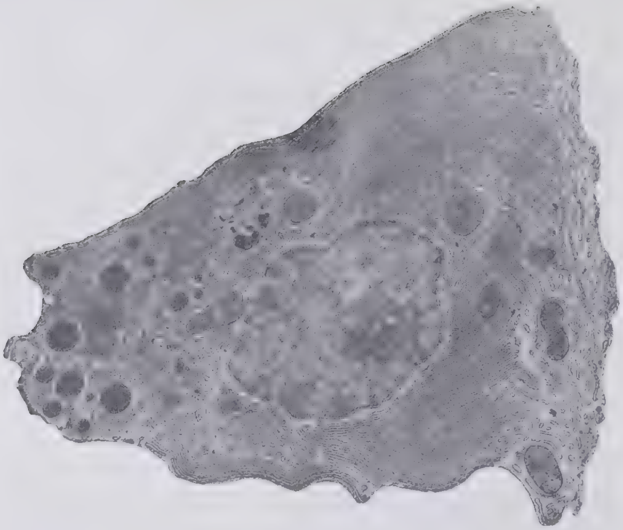
1-3. WHAT YOU SEE HERE is an electron microscope. It can magnify things thousands of times more than the microscope you have been using. The people who use electron microscopes have to be specially trained for the job. Only dead cells that have been stained and sliced into very thin layers can be looked at with an electron microscope.

3. The cell is the unit of function as well as structure.

4. Instruct your students to look for openings in the nuclear membrane.

Hard cover users: To reproduce the illustrations for Parts One, Two and Three of this Exploration please turn to page T 60 or direct students to the Laboratory Supplement.

→ H 128



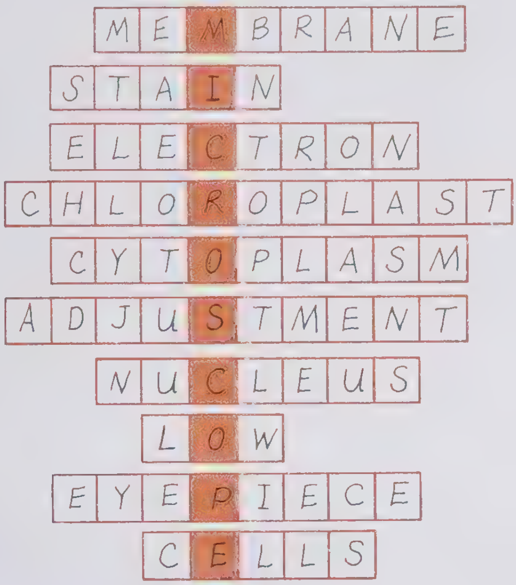
This photograph was made with an electron microscope. Does it look like a plant cell or an animal cell? How can you tell? Probably animal. No cell wall. No chloroplasts.

How is this photo different from your drawings of cells? I can see many more parts and channels. Nucleus and cell membrane have indentations.

4. On the photo of the cell trace a path that something could follow from outside the cell into the nucleus.

Also trace a path from the nucleus into the cytoplasm.

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 38 or direct students to the Laboratory Supplement.



1 MEMBRANE

2 STAIN

3 ELECTRON

4 CHLOROPLAST

5 CYTOPLASM

6 ADJUSTMENT

7 NUCLEUS

8 LOW

9 EYEPIECE

10 CELLS

Fill in the rows of this puzzle by using the clues below.

1. The outside layer of an animal cell.
2. You can often see cells better on a slide if you ____________ them.
3. A microscope that magnifies thousands of times.
4. Green parts in a plant cell.
5. Cells are filled with this thin jelly.
6. To get a focus with low power, you turn the coarse ____________ toward you.

7. The control center of a cell.

8. The ___ _______ power objective of a microscope is used first.

9. The part of a compound microscope you look through.

10. What Robert Hooke called the structures that cork is made of.

The letters in the colored squares form the name of an important tool of the biologist. Write the word here.

☐☐☐☐☐☐☐☐☐☐

6 Nutrition and Digestion

← H 129

→ H 130

Exploration 1. Diffusion

Overview

In an earlier Exploration the students hypothesized about the presence of openings in cell membranes and about the possibility of molecules moving through these openings. Studies on diffusion require abstract thinking on the part of your students. They can't touch, or see, or count molecules. To develop some consciousness about molecules we use five different activities.

We begin the first activity using a strong smelling liquid. After this, we use a solid that dissolves before it diffuses. Then we show students that two liquids in contact with each other will diffuse. And, finally, we make them aware that diffusion will take place through a membrane.

As the class works you should move about the room and check to see if directions are being followed. Diffusion is basic to the understanding of physiology and the cell as the unit of function.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) describe or define *diffusion.*
(2) give examples of diffusion.
(3) explain water transport in carrot roots.

Material for Teacher

bottle of ammonia

Exploration
1. Diffusion

1-3. Everything is made up of tiny bits of material called **atoms**. Atoms can group together into bigger bits called **molecules** (*MAHL uh kyools*). In liquids and gases the molecules are always moving and bumping into each other. In this way they travel from place to place.

If you open a bottle of perfume, the perfume molecules move out of the bottle, and air molecules move in. You smell the perfume because the molecules are moving from one place to another. This spreading out is called **diffusion** (*dih FYOO zhuhn*). Even after the air and perfume molecules have spread out and mixed evenly, they go on bumping and moving.

In today's lesson, you will learn something about diffusion. You will see that diffusion takes place with liquids as well as gases. Five activities will show you different points about this process. The last two take a few hours to show results.

4. Part One The Invisible Traveler

Your teacher will demonstrate this first activity. Take the top off the bottle of a strong smelling liquid (like ammonia). Set it in the front of the room.

Does the odor of the liquid travel? Yes.

How do you know? You can smell it.

Show where most of the ammonia molecules are in the room by marking 25 dots in the diagram on the left on the next page.

Where, in the room, are the fewest molecules? Show that by making 2 small checks in the same diagram.

How will you know when some of the molecules of the liquid get to the back of the room? You will smell ammonia.

Hard cover users: To reproduce the picture of the cell for this Exploration please turn to page T 60 or direct students to the Laboratory Supplement.

Materials for Each Group

glasses
water
Kool-Aid
spoon
large beaker or jar (400 ml)
small bottle with top
red ink
several raisins or prunes
carrot
potato peeler
one hole rubber stopper
glass tubing
syrup (molasses or pancake syrup)
melted wax
brush
ring stand with clamp

Time

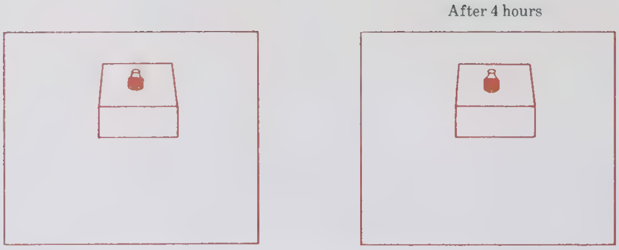
Three days

1. This activity follows the Exploration on the electron microscope in which it was suggested that cell membranes may have openings. Remind the class of this.

2. There may not be time to do all parts of this activity in one period.

3. If there is a lack of glassware, empty jars can be substituted.

Part One This is a demonstration. You will have a chance to start the class thinking about moving molecules.



How do the molecules get to the back of the room? They move and bump into each other.

What direction did the molecules move in? Did they go from a more crowded place to a less crowded place? Or did they go from a less crowded place to a more crowded place? From more crowded to less crowded.

Imagine how the molecules will be scattered in four hours. Show that by marking 27 dots on the right side of the diagram.

→ **H 132**

5. Part Two Do Liquids Diffuse?

Show on these drawings what happens to the Kool-Aid.

Place a glass of water on your desk. Do not touch it. Keep the water still for this test.

Carefully drop a small amount of Kool-Aid into the glass of water. Watch it for a few minutes without touching the glass.

What happens to the Kool-Aid as you watch it? Let students record observations.

After 1 minute

A small amount of ammonia in a flat dish or absorbed in a paper towel will evaporate much faster than in an open bottle.

5. Part Two The Kool-Aid should be dropped slowly on the surface of the water. It will go to the bottom and start diffusing.

Inexpensive clear plastic cups can be purchased in the supermarket and kept for making the Kool-Aid for this lesson. Use one for each member of the class, then add to the fun of this lesson by drinking the Kool-Aid.

Potassium permanganate, instant coffee, a hard candy or a cough drop can be used instead of, or in addition to, the Kool-Aid.

6. Part Three This might be done as a demonstration, although it is simple enough for each group to set up. Again, try not to set the water in motion as this will affect the speed of diffusion.

Keep one of these set up for a week or two without stirring. Students may be amazed at how slowly diffusion progresses.

How is this movement an example of diffusion? Molecules of Kool-Aid and molecules of water are moving.

Very slowly stir the water. Does this make diffusion faster or slower? Faster.

After 5 minutes

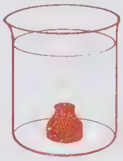
After stirring

6. Part Three Seeing Red

Put a small bottle of red ink in a large beaker of water. Slowly remove the top from the bottle after it is under water. Use tongs so you will not disturb the water. Watch it for a few minutes.

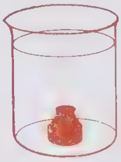
What happens to the red ink? Students record observations.

Show on these drawings what happens to the ink.



After 3 minutes

Why doesn't the bottle become empty? Water molecules are moving into the bottle.



After stirring

How is this movement an example of diffusion? Molecules of ink and of water are moving from an area of higher concentration to one of lower concentration.

Stir the water very slowly. What happens to the speed of diffusion?

It is speeded up.

Part Four Diffusion in Raisins

7. Place several raisins or dried prunes in a glass of water. Let them sit overnight. Keep some raisins dry for a control.

What do the dry raisins look like? Students describe.

What do the soaked raisins look like? Students describe.

What do you think caused this change? Water molecules moved into the raisins through the skin.

Is this an example of diffusion? Yes.

How is this diffusion different from the diffusion of Kool-Aid and red ink? The skin (membrane) separated the water from the inside of the raisins.

Do you see anything that makes you think some molecules might have diffused *out* of the raisins? Yes. Water is discolored.

Raisins and prunes are made of cells. The contents of the cell are held in by cell membranes and cell walls. How does this activity show that a liquid can move through cell membranes and cell walls? The water had to move through the cells of the skin to get inside. Then it moved from cell to cell.

7. Part Four The raisins or prunes might be put into a paper cup with water if glassware is not plentiful.

8. Part Five This takes a while to set up. One group or one student might be singled out to do this part if there is time.

The teacher should melt the wax in a double boiler and make it available to the students. Turn the flame off and keep the wax soft by leaving it in the hot water bath.

The syrup should fill the cavity in the carrot.

Results will be seen the next day.

Research Dialysis membrane that comes in a roll can be used. Tie one end of the tube to make a bag, fill it, and then tie the other end.

Large empty "horse" capsules that are purchased from a druggist or veterinarian can be used as a membrane. Fill them with test material and then place them in water or in another liquid.

Mangrove trees have roots that act like stilts. The roots hold the tree above the water.

8. Part Five How Do Roots Get Water?

← H 133

Put a check (√) next to the number after you finish each step of this activity.

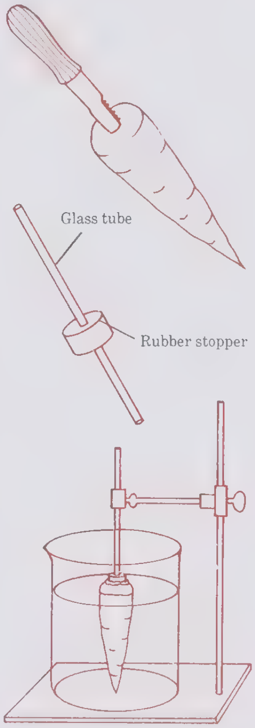
( ) 1. Use a potato peeler (or an apple corer) and scoop out a hole in the top of a carrot. Make the hole as deep as you can without cutting through the side of the carrot.

( ) 2. Choose a one-hole rubber stopper that will just fit the opening you made in the carrot. Wet the end of a piece of glass tubing 60–70 centimeters long and carefully put it into the hole in the stopper. Leave it there. Your teacher will show you how to work with the tubing so you don't cut your hand.

( ) 3. Now have someone in your group fill the hole in the carrot with syrup. Then plug the opening with the stopper.

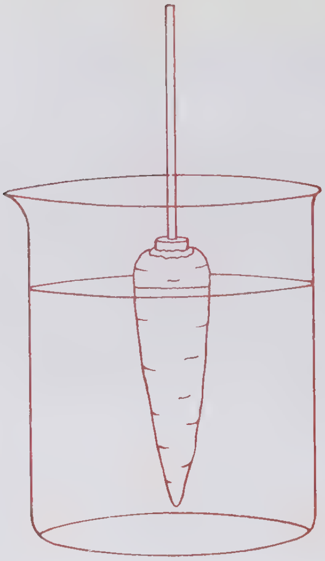
( ) 4. Use a brush to put melted wax where the stopper and the carrot meet. This will stop any leak you may have.

( ) 5. Set the carrot into a beaker and hold it upright while someone in the group sets a clamp to keep it that way. Add water to the beaker until most of the carrot is covered. Let it stand for several hours.



Hard cover users: To reproduce the illustration for the carrot activity for this Exploration please turn to page T 61 or direct students to the Laboratory Supplement.

Show on this drawing what happened to your setup.



What do you think caused the change that you see? Water molecules moved into the syrup.

Are there more water molecules crowded together outside the carrot or inside the carrot? Outside.

A carrot is made of cells. What does this activity show about a liquid passing from one cell to another? How can you tell? The water had to move from carrot cell to cell in order to reach the syrup.

A carrot is the root of a plant. Does this activity show that water can pass into a root by diffusion? Yes.

→ H 134

Check Yourself

1. What is diffusion? The moving of molecules from an area of higher concentration to one of lower concentration.

2. Give two examples of water passing through a membrane by diffusion. Water going into roots, and water that we drink going into blood.

3. Think of a hypothesis that explains how molecules may pass through cell membranes. The openings in the cell membrane let them through.

4. Some molecules cannot pass through the spaces in the cell membranes. Think of a possible reason for this. The molecules may be too big for the openings.

Research You Can Do

1. How could you test what effect temperature has on the speed of diffusion? Make the test if you can.

2. Plan tests to show if materials other than water will diffuse through a membrane. Your teacher will give you a piece of material to work with. (This works in the same way as a cell membrane.) You might want to try milk, starch, salt, tea, raw egg, oil, or soda. Do as many tests as you can and record your results.

Exploration
2. Finding a Meal

← H 135

Are you daring? Would you like to try foods from other lands? Eskimos eat whale meat and the layer of white fat around the whale called blubber. In a Greek restaurant you can order fried squid. The Japanese like to eat raw fish. Do you eat any foods your friends think are unusual?

Exploration 2. Finding a Meal

Overview

This Exploration is a survey of some animals and their methods of getting food. It might be appropriate to study two or three of these animals. Let students observe any animal as long as they wish. Don't rush.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) define or describe *food.*

(2) give several examples of different kinds of foods that various organisms eat.

Materials for Each Group

- organisms from pond water
- microscopes
- pipettes
- hydra
- planarians
- small piece of raw liver
- small mirror
- goldfish or guppy
- tubifex worms (or other small worms)

Time

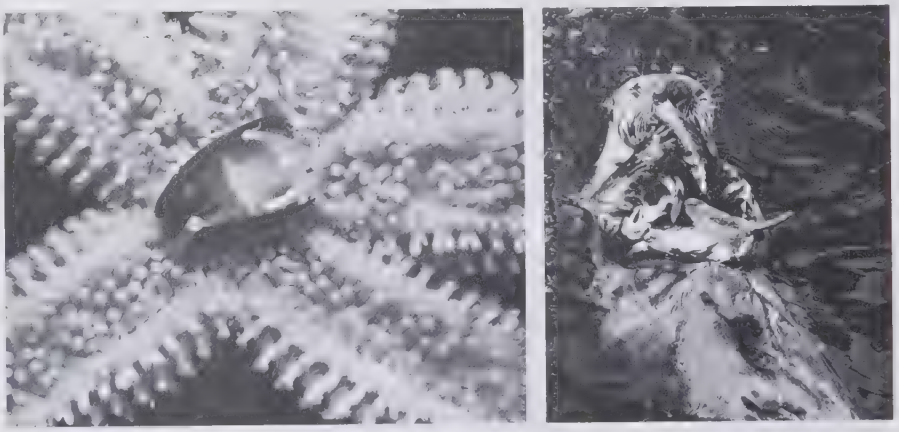
Three days

In this lesson you will observe some plants and animals to find out what they eat and how they take food into their bodies.

What does the word food mean to you? Let students express ideas.

What are some of the foods you eat? Students list foods.

What are some of the foods other animals eat? Let students speculate.



→ H 136

Starfish eat mussels. They have hundreds of tube feet that pull the shells apart. Otters like to eat on their backs. This one is eating a fish and holding a duck ready for a second course.

1. **Part One Food for One-Celled Plants**
Look at some one-celled green plants from pond water or water from a fish tank. Make a slide by using a drop of the water.

1. Remind students that they have already observed how some animals respond to food. Point out that living things eat a variety of substances.

Part One. Pond water or water from a fish tank should have some algae. Collect water that has green "scum" on it or scrape algae off the side of a fish tank. (Pleurococcus from the bark of a tree will make good slides.)

2. Part Two Pond water or fish tank water or a culture of protozoa are good sources.

Start cultures two or three weeks ahead.

Remember to check before the class to be sure that there are plenty of live materials for making slides. Students may or may not see any organisms feeding. However, organisms that are gathered around debris may be feeding on it.

Place the slide under the low power lens on a microscope. After you get some plants in focus, watch them for a few minutes. What do these water plants look like? Draw a picture of one of them in the margin.

Do you see these plants taking in food? No.

Where do these small water plants get their food? They make their own.

Can you see a green color in the plant? Yes. What is the name of this green material? Chlorophyll.

How does the plant use this green material? To make food.

How would these plants be important in a food chain? They make food that is used by animals.

2. Part Two Food for One-Celled Animals

Now you will observe some one-celled animals. Make a slide by taking a drop of pond water. Put the slide under the low power lens of a microscope and get a clear focus on the animals. Watch them for a few minutes.

Do these organisms move around? Usually, yes.

Describe the movements you see. Answers will vary.

Do you see any animals taking in food? Answers vary.

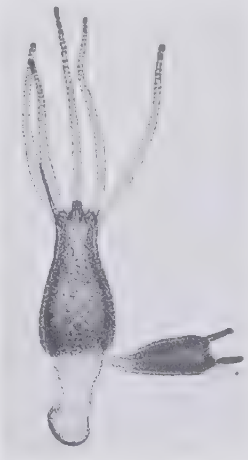
What do you think they use for food? Small plants or animals or decayed material.

← H 137

Where do they find food? In the water.

3. **Part Three Food for Hydras**

A new hydra can grow out of the side of an adult hydra. After a while the new hydra splits off and is on its own.



Courtesy of the Carolina Biological Supply Company

The **hydra** (*HY druh*) is a small animal that lives in water. It is made up of many cells. The hydra's body is hollow and shaped like a bottle with arms sticking out at one end.

Your teacher will give you a dish with hydra in pond water. Look at one with a magnifying glass. Your teacher will give you the food to feed the hydra.

Can you see the hydra without using a magnifying glass? Yes.

What movements does the hydra make? Students record observations.

How does the hydra respond to the food you gave it? Answers vary.

What kind of food does it eat? Small living animals in the water.

How does the hydra take food into its body? Pulls it into the "mouth" with its arms.

4. **Part Four Food for Planarians**

Planarians (*pluh NAIR ee uhns*) are flatworms that live in fresh-water streams. Your teacher will give you a dish with a few living planarians. If you have a mirror, place the dish on top of it to watch what happens. Put a small piece of fresh liver in the dish. Watch the flatworms for a few minutes. Describe how they move.

Students record observations.

3. Part Three Living hydra may have to be ordered from a supply house. If so, time must be allowed for delivery. Sometimes hydra are found in pond water or attached to the side of the plants in a fish tank. Daphnia (ordered from a supply house or bought from a pet shop) is good food for the hydra.

4. Part Four Unless planaria are kept in your school, they may have to be ordered. If you get some, try to keep them alive for Chapter 12. (See Exploration 4, Replacing Lost Parts).

If you want to collect your own planaria, a piece of liver in an open jar placed in a pond or stream may trap them. Have students observe what happens when the piece of liver is placed at one end of the dish containing the worms. A small mirror placed under the dish will help make the feeding easier to see.

Be sure that the planaria are put in clear dishes with clear water (not tap water) after they feed.

5. Part Five A fish in a small tank or large jar can be placed on each desk.

Feed the fish bits of earthworm or packaged fish foods.

Hard Cover Folios Preceded by H

How do they respond when you put the food in the water? Students record observations.

How do these flatworms take food into their bodies? Through a tube that is in the middle of the body.

What do you think the planarians use for food in the freshwater streams where they live? Dead animal matter.

A planarian

5. Part Five Food for Fish

Your teacher will give you some fish. Watch them closely. Why do the fish open and close their mouths when they are *not* eating? They breathe by taking oxygen out of water.

What else do you notice about the way they move? Students record observations.

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Your teacher will give you food to feed the fish. After you drop it into the water, watch the fish closely.

What kind of food are you using? Answers will vary.

How do the fish respond when you put the food into the water? Students record observations.

Do the fish eat the food you give them? Varies.

If you wish, give the fish more food and watch their mouth movements. Write a sentence to describe what you see. Students record observations.

Is this the kind of food the fish would eat if they were living in a stream or lake? Answers vary.

Check Yourself

1. Make a summary of this lesson by filling in the chart.

Organism	Where does it live?	What does it eat?	How does it take in food?
One-celled plant	Water	Makes own food	
One-celled animal	Water	Small plants, animals, decayed matter	Through "mouth"
Hydra	Water	Small animals	Arms pull food to "mouth"
Planarian	Water	Dead material	Through a "tube"
Fish	Water	Plants, animals	Through "mouth"

What does the word food mean to you? Answers vary.

Is your answer to this question the same as it was at the beginning of this lesson? Answers vary.

← H 139

Reading
3. The Food Story

The king thinks that the hamburgers are getting bigger and bigger. Winning a hamburger-eating contest seems to take away your appetite.

1. Diffusion is one way that the food you eat gets into your cells. Is everything you eat the kind of food your cells need? Are some kinds of food better than others?

How would you like to go on a chocolate cake diet? All you could eat was chocolate cake. Cake for breakfast. Cake for lunch. Cake for dinner. Every day. Would you enjoy it? Would the cake supply all of your food needs?

Some animals do eat only one kind of food. Cows eat only grass. Many sharks eat only flesh. But people need to eat different kinds of foods to be healthy.

2. Foods contain chemicals called **nutrients** (*NOO tree uhnts*). You need to eat foods that supply six different nutrients. These are **proteins**, **carbohydrates** (which include sugars and starches), **fats**,
3. **vitamins**, **minerals**, and **water.** Each kind of nutrient does an important job inside your body. They all work as a team to keep you healthy. Carbohydrates (*kar boh HY drayts*) and fats are

← H 140

Reading 3. The Food Story

1. You may have to review the terms diffusion and the structure of the cell membrane with your students. But, do not suggest that diffusion is the only or even the primary way that cells get food. Active transport is very important in moving materials from the blood into the cells against a concentration gradient.

Active transport enable cells to continue to concentrate nutrients such as glucose even after there is a greater concentration of it in the cells than in the bloodstream. The mechanism of active transport are not understood yet, but you can mention the process to the students.

2. Vegetarians get their proteins from eggs, cheese, beans, and milk dishes.

3. One scheme of classifying nutrients does not include water.

needed for energy. Proteins (*PROH teens*) may be used for energy but are needed mainly for growing and building parts of the body. Vitamins and minerals are chemicals that keep the body working properly.

People can go without food for weeks. But no one can live more
4. than a few days without water. Water in your blood is needed to
carry food to your body's cells and to carry away wastes. More
than three-fourths of your body weight is water.

Your body needs fuel for energy to make it work. Food is your body's fuel. It supplies the energy you need. Your body burns food, the way a car burns gasoline.

The amount of energy you get from food can be measured as
5. heat energy. The unit of heat energy that scientists use for this
measurement is the **calorie** (*KAL uhr ee*). The number of calories you need in a day depends on your age and size and on how much you exercise.

One glass of orange juice contains about 100 calories. You use
6. up 100 calories of energy during a 20-minute walk. Even when you
are asleep you use calories. In the chart you can see examples of the calories some foods supply. Pick out some of the foods that will supply you with the energy for a 20-minute walk.

CALORIE CHART

Food	Calories	Food	Calories
Apple	80	*Ice cream, vanilla—½ cup*	200
Baked beans—1 cup	300	*Ketchup—1 tablespoon*	18
Beef stew—1 cup	210	*Milk, skim—1 glass*	89
Beer, lager—1 glass	104	*Milk, whole—1 glass*	160
Bread, white—1 slice	65	*Oatmeal, cooked—1 cup*	135
Butter or margarine—1 tablespoon	100	*Orange*	70
Cake, chocolate with icing—1 slice	445	*Peanut butter—1 tablespoon*	100
Carrot, raw	20	*Pizza, cheese—1 piece*	185
Cheese, American—1 slice	105	*Pork chop, broiled*	295
Cheese, cottage—½ cup	100	*Pork sausage—1 serving*	340
Chicken breast, fried	230	*Potato, sweet, baked*	155
Cola or root beer—1 glass	96	*Potato, white, baked*	100
Corn flakes—1 cup	80	*Rice, white, cooked—1 cup*	180
Egg, boiled	80	*Spaghetti, tomato sauce—1 cup*	260
Egg, scrambled	110	*Spinach—1 cup*	40
Green beans—½ cup	20	*Steak, sirloin—1 serving*	300
Grits, cooked—1 cup	120	*Sugar, white—1 tablespoon*	46
Ham, baked—1 serving	340	*Tomato, raw*	30
Haddock, broiled—1 serving	160	*Tuna fish, canned—½ cup*	220
Hot dog	150	*Yogurt—1 cup*	125

4. Students know that tears, sweat, urine, and saliva contain water.

5. If you can burn a peanut and measure the amount of heat that is given off and if you can eat a peanut and could measure the amount of heat energy that would be given off, the two amounts would be the same. The heat would be measured in calories. In fact, a chart can be made because caloric values are determined by burning food in calorimeters.

6. The chart can be used by students who want to find out how many calories they eat in an average day. This can be an activity for the class or an extra report. Others may want to make a list of those foods that are high in calories. Have some students record how many calories they eat in an average day for a period of one week.

Exploration 4. Nutrient Tests

Overview

In this activity we take some giant steps toward the general objectives of this program such as following directions, drawing conclusions, predicting, making observations, and recording data. The students will also gain additional background that they will need later when digestion is studied.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) test foods for starch content and record their results.
(2) test foods for glucose content and record their results.

Exploration
4. Nutrient Tests

1-4. YOU MAY THINK you can tell what a food is by looking at it. Maybe so. But it isn't that easy to tell what nutrients it contains. We have tests to show if a certain food contains fat, starch, glucose, or protein. **Glucose** is the kind of sugar the body uses.

Today you will practice using these tests. In most cases, the chemical you test with will show a color change when it is mixed with a particular nutrient.

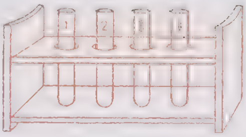
Follow these steps for the first three tests in this lesson. Get four test tubes. Number them 1, 2, 3, and 4.

In test tube No. 1, put 10 drops of glucose solution.

In test tube No. 2, put 10 drops of starch solution.

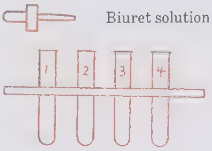
In test tube No. 3, put 3 small pieces of hard-boiled egg white. This is your protein sample.

In test tube No. 4, put 10 drops of fat.



5. Part One A Test for Protein.

After doing the test, complete the title of Part One.



Add four drops of Biuret solution to each test tube. Which test tube shows a color change? Tube 3.

What color is it? Purple.

Do the other test tubes show any change? No.

Which kind of nutrient can be identified by using Biuret solution?

Protein.

Record your results on the chart on page 220. Use a plus (+) sign if you had a color change and a minus (−) sign if there was no change.

6. Part Two A Test for Starch.

After doing this test, complete the title of Part Two.

(3) test foods for protein content and record their results.
(4) test foods for fat content and record their results.

Materials for Each Group

4 test tubes
rack to hold test tubes
glass-marking pencils
glucose solution
starch solution
hard boiled egg white
cooking oil
Biuret solution
brush for test tubes
iodine solution
Benedict's solution
pieces of brown paper (paper bag)
1 or 2 large beakers of boiling water to be used by the whole class
pipettes (medicine droppers)

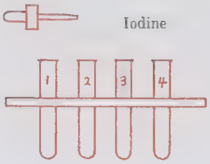
Time

Two days

1. The percentages of glucose and starch that you use are not critical.

2. You might point out that there are more sophisticated ways of testing food.

3. The four test tubes should be numbered with a glass marking pencil. Use the same nutrient in each test tube for all activities. This will avoid contamination if the test tubes are washed carelessly.



Wash out the test tubes very carefully. Set them up again with the four nutrients as you did for Part One. Then put 4 or 5 drops of iodine into each test tube.

Which test tube shows a color change when the iodine is added?

No. 2. Starch.

What color is it now? Blue or blue-black.

Do the other test tubes show a change? No.

Which kind of nutrient can be identified by adding iodine?

Starch.

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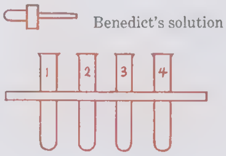
Record your results for this test on the chart. Use a plus (+) sign if there was a color change and a minus (−) sign if there was no change.

7. Part Three A Test for Glucose.



After doing this test, complete the title of Part Three.

Wash out the test tubes very carefully. Set them up again with the four nutrients as you did for Part One. Add 10 drops of Benedict's solution to each test tube. Place the four test tubes in hot water. Watch them until you see a color change.

Which test tube shows a color change? No. 1. Glucose.

What color is it? Orange.

Do the other tubes show a change? No.

Which kind of nutrient can you identify by adding Benedict's solution and heating? Glucose.

Record your results on the chart. Use a plus (+) sign if there was a color change and a minus (−) sign if there was no change.

4. Stress cleanliness and care in using chemicals. Be sure that each chemical is labeled to avoid confusion. Point out that since color is the result we look for, foods that have color, mask the results.

5. **Part One** For accurate results in the protein test the Biuret solution should be mixed just before it is needed. It is purchased in two bottles and is easily mixed.

6. **Part Two** Be cautious when using the iodine.

7. **Part Three** Get across the idea that green color indicates a small amount of glucose. This is the sugar tested for by a diabetic.

8. **Part Four** A more exact test for fat involves the use of ether. Ether is dangerous to use in a class room.

Don't collect these activities because the information will be needed for the next Exploration.

8. Part Four A Test for Fat.

After doing this test, complete the title of Part Four.

You will use a piece of brown paper instead of a chemical for the last test. Place a small amount of each kind of nutrient on a piece of brown paper. Mark each piece of paper with the name of the nutrient and let it dry. Hold the pieces of paper up toward the window, and look at the spots.

Which nutrient left a spot that didn't seem to dry? Fat.

Do you think this spot will ever dry? No. Why? Students know a grease spot doesn't dry.

Which nutrient did you identify with a piece of brown paper? Fat.

Record your results on the chart. Use a plus (+) sign if there was a grease spot on the paper and a minus (−) sign if there was not.

Check Yourself

1. What is the test for starch? What chemical do you use and what color change do you get? Add iodine. The result is blue coloring.

2. What is the test for glucose? Add Benedict's solution and heat. The result is orange coloring.

3. What is the test for protein? Add Biuret solution. Result is purple coloring.

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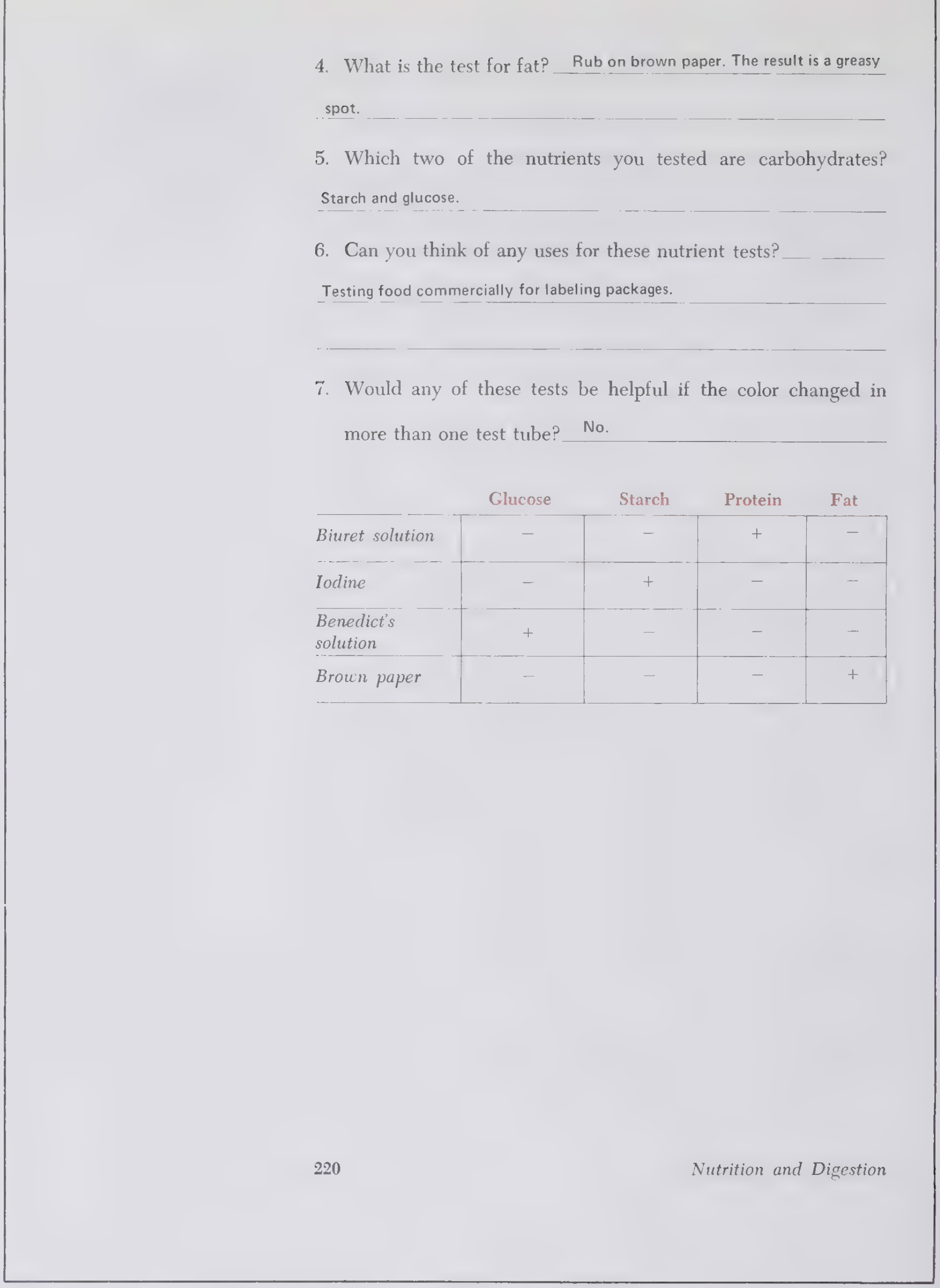

4. What is the test for fat? Rub on brown paper. The result is a greasy spot.

5. Which two of the nutrients you tested are carbohydrates? Starch and glucose.

6. Can you think of any uses for these nutrient tests? Testing food commercially for labeling packages.

7. Would any of these tests be helpful if the color changed in more than one test tube? No.

	Glucose	Starch	Protein	Fat
Biuret solution	−	−	+	−
Iodine	−	+	−	−
Benedict's solution	+	−	−	−
Brown paper	−	−	−	+

Exploration 5. Using the Nutrient Tests

Overview

Encourage the students to use the food test charts that were prepared in the last activity. You should have many different kinds of food available. Allow as much individual work as possible. Be sure, however, that accurate records are kept. This is an exercise in observation, drawing conclusions, and recording data.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) identify the nutrients that foods contain.

Materials for Each Group

assortment of foods
water
4 test tubes
iodine solution
Benedict's solution
Biuret solution
rack for test tubes
brown paper
pipettes (medicine droppers)

Time

One day

1. Although the students are asked to bring in food, the teacher should be prepared with an assortment.

Exploration
5. Using the Nutrient Tests

1-5. Today you will be testing several different foods to see what nutrients they contain. Keep track of your results on the chart.

Members of the class will bring in foods from home. Each group should have about 10 different kinds of food to test. Some good choices are milk, crackers, bread, apples, cheese, potato, rice or macaroni (cooked or raw), fruit juice, egg, candy, onion, and baby food.

You will find out which of these foods contain starch, glucose, protein, or fat.

The Foods You Test	Starch	Glucose	Protein	Fat
		Answers will vary.		

6. Part One Starch

Test as many foods as you can to find out which ones contain starch.

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2. Choose foods that are colorless or lightly colored as they make it easier to observe results.
3. A good "unknown" to use is baby food with the label removed. Try puddings or meat mixtures.
4. The number of days spent on this activity depends on the interest of the class. One day may be sufficient or three may be warranted.
5. Watch the clean-up time. This laboratory can leave a real mess.
6. **Part One** Dry foods may be tested by placing them on a dish and adding iodine.

What test do you use for starch? Iodine.

What color change do you look for? Blue.

Keep a record of your results on the chart. Use a plus (+) sign if starch is present and a minus (−) sign if it is not.

Part Two Glucose

Test as many foods as you can to find out which ones contain glucose (the body sugar).

What test do you use for glucose? Benedict's solution.

What color change do you look for? Orange (green, if there is only a little).

Keep a record of your results on the chart.

Part Three Protein

Test as many foods as you can to find out which ones contain protein.

What test do you use for protein? Biuret solution.

What color change do you look for? Purple.

Keep a record of your results on the chart.

7. Part Four Fat

The test for fat that you learned in the last section will work only if there is a lot of fat in a food. Test as many foods as you can by using the test you know.

What is the test that you learned for fat? Rub on brown paper, look for greasy spot.

Keep a record of your results on the chart.

7. **Part Four** Fats will leave a translucent spot more readily if the food is put on a radiator or in an oven.

Usually two or three students know a person with diabetes and can contribute some information on the subject. The Metropolitan Life Insurance Company pamphlet on diabetes is useful.

Check Yourself

1. Which of your foods contain a lot of starch? Answers will vary.

2. Which of your foods contain a lot of glucose? Answers will vary.

3. Which of your foods contain a lot of fat? Answers will vary.

4. Which of your foods contain a lot of protein? Answers will vary.

5. Why are eggs and cheese called "meat substitutes"? Because they contain protein and can be served in place of meat.

What nutrients do you think these foods supply?

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Research You Can Do

People who must plan their diets carefully need to know what nutrients are in their food. You might want to find out what special diets these people need:

a person with diabetes ______

a person with anemia ____________________

____

a person who is allergic to milk and eggs ____________________

____

a person who is 45 pounds overweight ____________________

____

Exploration 6. Vitamins

Overview

Be sure that the students read the introduction to this activity. It gives the background for this section of work. The objective is not to memorize facts about vitamins. Rather, it is to learn to handle information that is on the vitamin chart and to learn some elementary information about the need for vitamins. Hopefully, students will be able to look critically at their own daily intake of food.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) list foods containing vitamins A, B complex, C, D, E, and K.

Materials for Each Group

pencils

Time

Two days

1. You may want to discuss some of the history on how some vitamins were discovered.

2. People must eat more than the proper proportion of carbohydrates, proteins, fats, and minerals to obtain the essentials of a good diet. They also need vitamins.

3. Vitamin pills should not be used as a substitute for a well-balanced diet.

4. Vitamin pills may supplement a well-balanced diet if ordered by a physician.

5. You need some of each vitamin daily.

Exploration
6. Vitamins

1. Two HUNDRED YEARS ago there were no refrigerators. So sailors at sea ate salted meat and bread. The ships did not usually carry fresh fruit and vegetables. When the sailors were at sea for several weeks, they became sick with **scurvy** (*SKUHR vee*). Their gums bled. Teeth fell out. Men grew too weak to move. Some died.

A doctor in the British navy, James Lind, tested an idea he had about scurvy. He chose 12 sailors who had scurvy for his experiment and divided them into six pairs. He gave one extra food to each pair. One of the pairs of men was given a lemon and two oranges every day. Only six days later these two men were better. The men who had been given other things were still very sick.

Dr. Lind thought oranges and lemons were wonder drugs. That was 1747. Today we know that they contain vitamin C. This is an important part of a balanced diet.

2. Now scientists have learned about several other chemicals called **vitamins.** The name comes from *vita*, meaning "life." You need vitamins for a healthy life.

Most Americans do not need to worry about getting sick from
3. a lack of vitamins. But many people do not get enough vitamins to feel really well. They may feel tired all the time. Or they may
4. have skin problems or a poor appetite. Or they may get more than their share of colds.

The chart on the next page lists six different kinds of vitamins. Study the chart to see what foods supply each vitamin.

← H 146

5. Use the vitamin chart to answer the following questions.

What are some good food sources of vitamin E? Record from chart.

How is the vitamin B complex important? Record from chart.

What are some good food sources of vitamin B? Record from chart.

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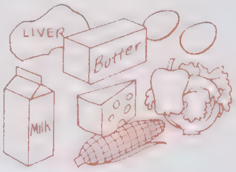
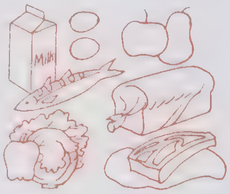
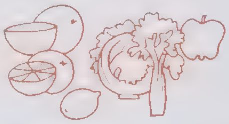
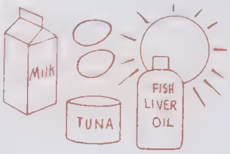
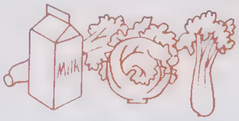
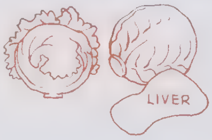
Vitamin	Sources	Needed for	Signs of Deficiency
A		*Good vision* *Proper growth in babies* *Resistance to infection*	*Night blindness* *Dry skin* *Gets infections often*
B complex		*Normal growth* *Good skin* *Healthy nervous system*	*Retarded growth* *Poor digestion* *Mouth and skin troubles* *Anemia* *Nervous system disorders*
C		*Healthy gums* *Resistance to bruising*	*Scurvy* *Bruise easily*
D		*Straight leg bones* *Keeping a good supply of calcium in bones, for growing children*	*Poor development of bones and teeth* *Rickets*
E		*Probably plays a part in general health*	*Unknown in people*
K		*Prompt blood clotting and recovering from wounds*	*Blood does not clot easily* *Brain hemorrhage in newborn babies*

How is vitamin C important? Record from chart.

What are some good food sources of vitamin C? Record from chart.

How is vitamin D important? Record from chart.

What are some good food sources of vitamin D? Record from chart.

Rickets makes children bow-legged. It's caused by too little vitamin D.

How is vitamin A important? Record from chart.

What are some good food sources of vitamin A? See chart.

What is the best way to be sure you are getting all your vitamins? Choose a proper diet.

Check Yourself

Choose the vitamin from column 2 that best matches each item in column 1. Write the answer on the line. If you need help, look at the vitamin chart.

Column 1

A 1. important for good eyesight
D 2. the sunshine vitamin
C 3. may prevent colds
B 4. a group of vitamins
B 5. important for healthy nerves
A 6. in yellow fruits and vegetables
D 7. important for strong teeth and bones
C 8. in orange juice
A 9. in egg yolk, carrots, and butter
B 10. a group of vitamins in cereals

Column 2

Vitamin A
Vitamin B complex
Vitamin C
Vitamin D

Research You Can Do

Look at as many food labels as you can. Cut out at least three that tell you about vitamins. A hint: Start by checking bread, milk, and margarine packages. Bring your labels to school. Compare them with labels your friends found.

→ H 148

Exploration 7. Minerals and Water

Overview

We complete the overview of the six nutrients (carbohydrates, protein, fat, vitamins, minerals, and water) in this Exploration. Once again, a chart is used and the students are directed to secure their information from it. The four minerals on the chart are those that are most familiar. They are minerals that the students can control in their diet. Make the point, however, that there are many other minerals that are needed for good health.

The emphasis on the care of teeth is deliberate. Many students have poor teeth because of poor diets and fear of going to the dentist. Often these boys and girls start the day off with soft drinks, cake or candy, and this diet may be repeated for lunch. The importance of visiting a dentist regularly, together with a proper diet, should be stressed.

Some of your students may be familiar with dehydrated foods. They have heard about "iron-poor" blood and this may be a good place to start our study of minerals.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) give reasons why minerals are important for good health.
(2) list several foods that supply you with water.

Materials for Each Group

bread or nuts
apple

Exploration

7. Minerals and Water

YOUR BODY needs **minerals**, too. Like vitamins, minerals are important parts of food — even though most of them occur in tiny amounts.

1. Part One Minerals Don't Burn

Weigh a piece of bread or a nut. Keep a record of its weight. Your teacher will burn the food by holding it in a flame until only an ash is left. Watch carefully for any changes. Weigh the ash and record its weight.

Weight of ash Answers will vary.

What food did you use? Answers will vary.

What does the ash look like? Students record observations.

Minerals do not burn easily. The ash contains the minerals that were in the food, as well as carbon. The food also contained other nutrients, like carbohydrates or protein. What do you think happened to the other nutrients? They burned up.

How much weight was lost by the burned food? Answers vary.

Why do you think there was a loss of weight? Some nutrients burned up.

When your teacher burned the food, was there any sign that it contained water? Probably yes. Some vapor or sizzling.

You need calcium for strong bones and teeth. If you take all the calcium out of a bone, you can tie it in a knot!

bunsen burner
forceps
balance and weights
red and blue pencils

Time

Two days

1. Part One When you weigh the bread, you will be using the metric system. Point this out.
The concept of a calorie is a difficult one but the class should know that a calorie is a measurement of the amount of energy that is supplied by food.

What happened to the water? It evaporated as burning took place.

What foods can you name that contain more water than the food you used for this experiment? Most fruits, vegetables, and meat.

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2. Part Two A Mineral Quiz

Study the chart on minerals. It shows only four of the many minerals that you need for good health.

Mineral	What it Does for You	Some Good Sources
Iron	*builds red blood cells*	*liver, eggs, milk, green vegetables, beans*
Calcium	*builds strong bones and teeth; builds healthy nerves and muscles*	*milk, cheese, celery, nuts, green vegetables*
Iodine	*controls use of food for normal growth*	*iodized salt, salt water fish*
Phosphorus	*builds healthy body cells, strong bones and teeth*	*liver, milk, meat, chicken, eggs, beans*

Sometimes we hear about iron-poor blood. What effect does a lack of iron have on the body? Lowers the number of red blood cells (anemia).

Instead of taking pills for iron-poor blood, what foods can you eat? See chart.

2. **Part Two** Students should begin to realize that minerals are important for the normal functioning of the body.

What two minerals are important for good bones and teeth? ______

See chart.

What are three foods that will give you both iron and phosphorus?

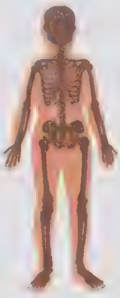
See chart.

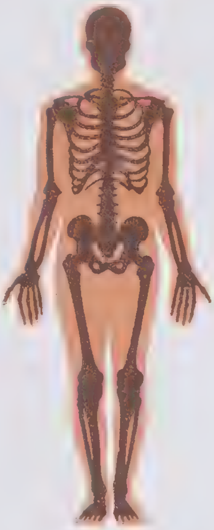
What is one food that will give you both calcium and phosphorus?

See chart.

You need only a small amount of iodine, but it is very important to get it. What is a good source of iodine? See chart.

Where does all the calcium come from to turn a child's skeleton into an adult's skeleton?





Check Yourself

1. From what you know about your own body, think of a hypothesis to explain why water is important to the body. To make blood, urine, sweat, tears, and cell contents, for example.

2. Guess what percent of your body is made of water. Answers vary. An estimate of 60 to 70 percent is about right.

3. To answer question 1 you made a hypothesis. To answer question 2 you made a guess. What do you think is the difference between a hypothesis and a guess? Hypothesis is based on thought and observation. A guess is less thoughtful.

4. What foods supply you with water? Most fruits, vegetables, soups, juices, milk, and others.

5. What is meant by "dehydrate"? Use a dictionary or ask someone at home to help you answer this. To remove water.

6. Some foods are dehydrated to keep them from spoiling. Can you name a few? Powdered milk, eggs, dehydrated soups, cereals, and others.

7. What must be added to dehydrated soups, milk, or potatoes before you use them? Water.

→ H 150

Research You Can Do

Look at as many food labels as you can. Cut out at least three that tell you about minerals. A hint: Start by checking bread wrappers and cereal boxes. Bring your labels to school and compare them with other people's labels.

Exploration 8. Can You Tell a Good Meal When You See One?

Overview

Today's activity encourages students to take a hard look at their own daily diet after they criticize two sample menus. It is important to teach the "basic four" groups of food as the key to understanding a balanced diet. Refer to the illustration in the book and have the class suggest additional foods to list for each group.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) write a menu for one meal containing the basic four parts.

Materials for Each Group

pencils

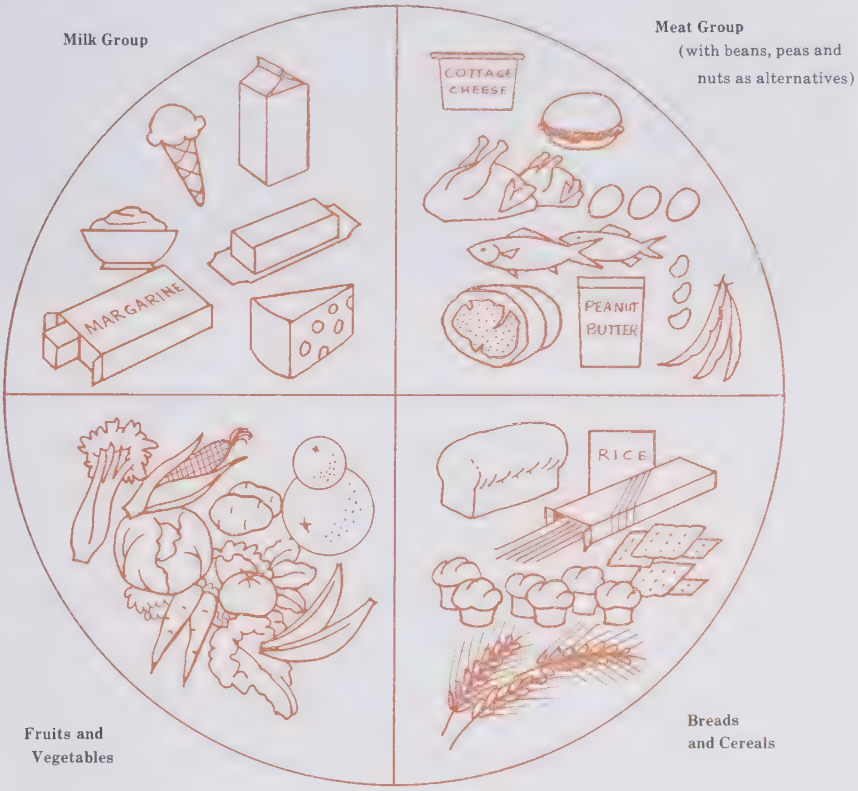
Time

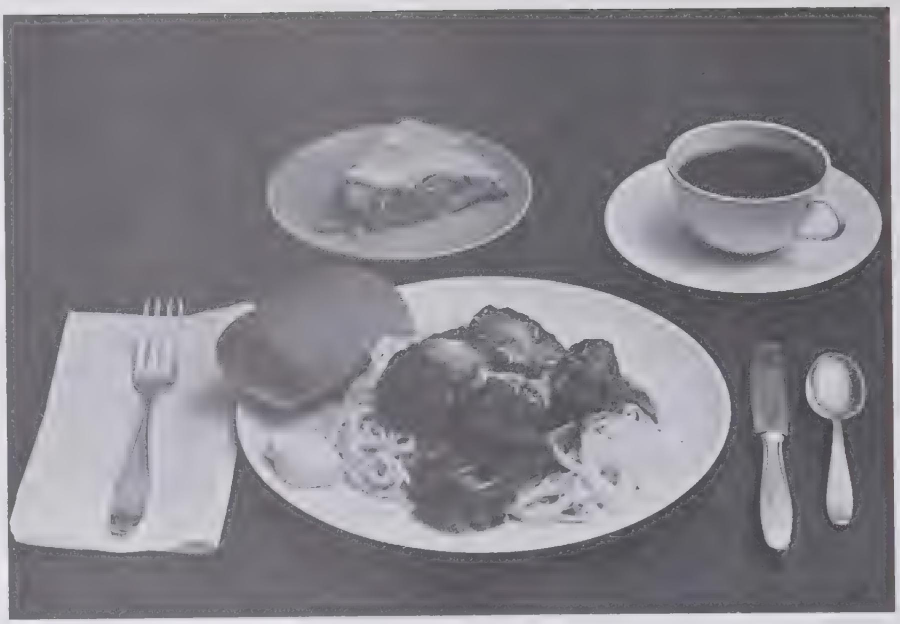
Two days

1. Learning to use the chart is one of the goals of this activity.

Exploration
8. Can You Tell a Good Meal When You See One?

1. When is a meal a good one? Today you will learn how to judge. Use the chart below showing the main food groups.





This was John's dinner one day.

H 151

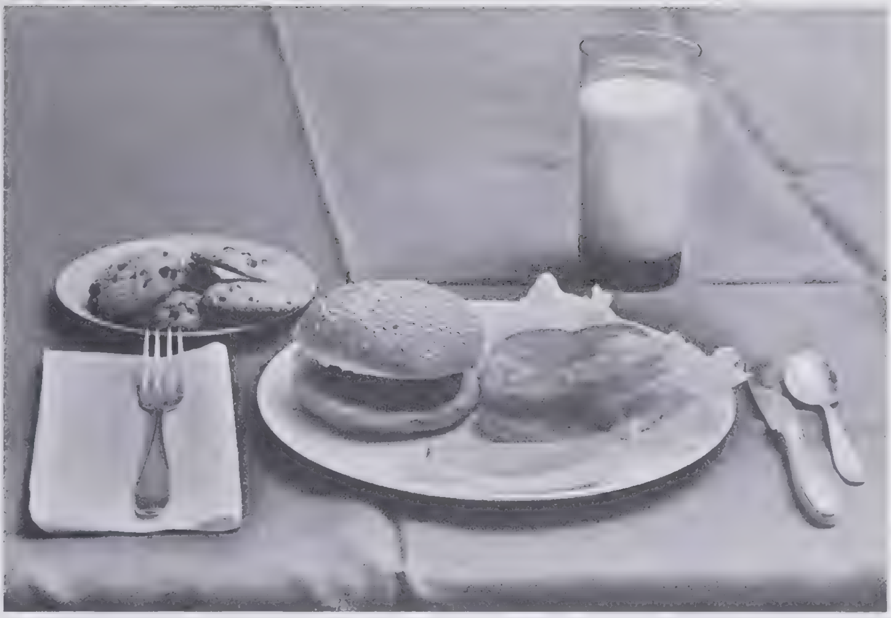
2. Which foods supplied John with carbohydrates? Teacher may need to supply answer.

Which foods supplied him with proteins? Teacher may need to supply answer.

Look at the chart on page 233. Does this meal supply all the nutrients John needs? No.

How could you improve on this meal? Milk group. Fruit and vegetables.

2. Hopefully, the student will begin to recognize when one of the basic foods is missing.
Students are not always honest when they are asked to list the foods they have eaten. However, try not to embarrass anyone by a show of disbelief when you see how little someone has eaten, or how inadequate a student's diet has been.



Anna had these foods for lunch one day.

Look at the chart. Does this meal supply all the nutrients Anna needs? Teacher may need to supply answers.

Name two other foods that could be used in place of the hamburger.

Chicken, peanut butter.

What could be used in place of the bun? Bread, biscuit.

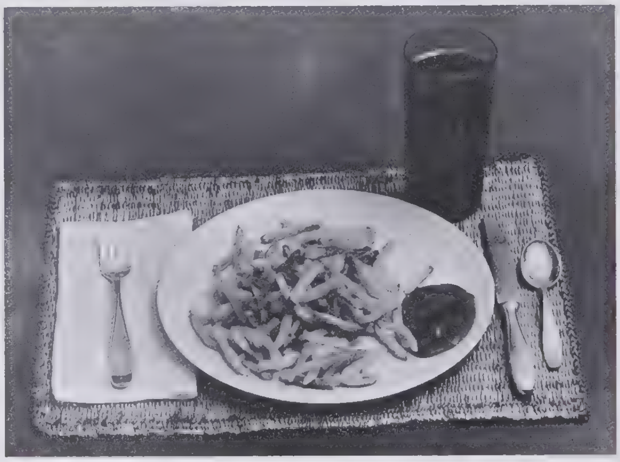
What could be used in place of the salad? Celery, corn, or other vegetables.

What nutrients does this soup contain? 3.

What about your meals? List everything you have eaten today. Then check the chart on page 233. Have you had most of your basic food needs already? Now list the foods you should add to supply all the nutrients you need for the day.

Foods you have eaten today	Foods you can add to supply the nutrients you need
Answers will vary.	

Is this a good lunch? What nutrients does it supply? Which nutrients are missing?



3. **Product** **Cup-a-Soup Cream Style Chicken**

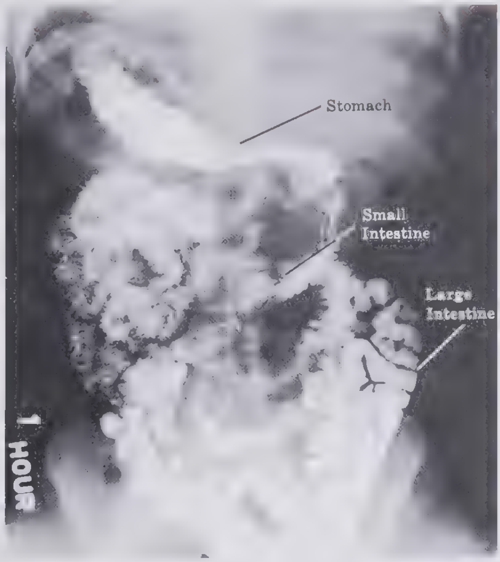
Nutrition Information Per Serving

Serving Size	1 envelope
Serving Per Container	1
Calories	90
Protein, Grams	3
Carbohydrate, Grams	10
Fat, Grams	5

Percentage of U.S. Recommended Daily Allowances (U.S. RDA)

Protein	2
Vitamin A	*
Vitamin C	*
Thiamine	*
Riboflavin	4
Niacin	*
Calcium	2
Iron	*

* Contains less than 2% of the U.S. RDA for these nutrients.



An X-ray of the upper part of the digestive system.

1. WHEN YOU have eaten a cheese sandwich, some of it is changed into you — into your muscles, bones, and blood. But many changes have to take place first. The food must be broken down so that it can get into the cells. The process that breaks down food to enter cells is **digestion** (*dy JEHS chuhn*).

2. Digestion starts while the food is in your mouth. Then the food goes down to your **stomach** through the **gullet**. From the stomach it goes to the **small intestine**, and from there to the **large intestine**.

All these organs form a long tube that is a kind of chemical laboratory. The work of the tube is to break down into smaller molecules the molecules of food that are too big to get into the cells. The small molecules can pass into the blood, and out of the blood into the cells.

← H 153

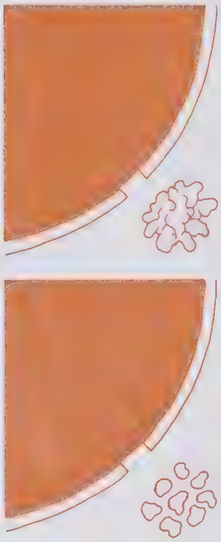
The small intestine completes the work of digestion. Digested food diffuses into the blood from the small intestine. You need

Reading 9. How Digestion Works

1. You may need to review the structure of cell membranes.

2. The length of the small intestine will have to be converted to feet. One technique is to measure out 6 meters and mark it on the floor or chalkboard.

Big molecules have to be broken down so they will fit through the holes in cell membranes.



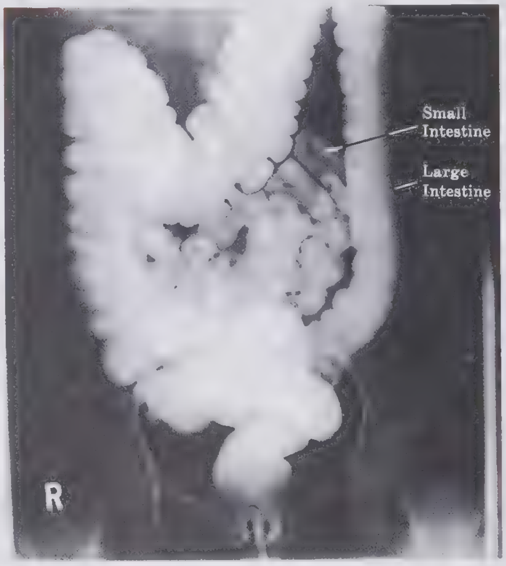
a long digestive tube to get the work done. Your small intestine is about 6 meters long.

The part of the food that can't be digested isn't used by your body. It goes into the large intestine and leaves the body as solid waste.

The vitamins, minerals, and water in your food can enter your cells without being changed. Other nutrients can't. Proteins, fat, starch, and some sugars have molecules that are too big to pass through the cell membranes. These nutrients must be broken down in the digestive tube into smaller parts. Then they can move through cell membranes more easily.

3-4. **Digestive glands** are attached to the food tube. These glands make juices that contain **enzymes** (*EHN zyms*). The enzymes are chemicals that break down food molecules into smaller parts. Enzymes used in digestion are made by the glands in the mouth, the stomach, and the intestines, and by a larger gland called the **pancreas** (*PANG kree uhs*). The largest gland in your body is your **liver.** Among many other jobs, your liver gives off a juice used in digestion. This does not contain enzymes, but is used to break down large drops of fat. The juice is stored in your gall bladder until it is needed.

There are many steps to digestion. Your body has to do a lot of work to digest the food you eat. And this is only the first step in changing a cheese sandwich, or anything else you eat, into you.



An X-ray of the lower part of the digestive system.

3. The word gland may need an explanation. Point out that the digestive glands are duct glands.

4. The enzymes that are found in detergents (these may be the only ones that the students have heard of) break up molecules of grease or other stains that are on the soiled clothes.

Exploration 10. The Digestive System

Overview

The objectives of this Exploration are to have students understand the tube-like nature of the alimentary canal and the relationship of the glands to the tube. On a chart, students will observe the position of the digestive glands. Be sure the class does the preliminary Reading, "How Digestion Works," before they begin this Exploration.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) name the five parts of the digestive tube.

(2) describe how the three glands connected to the digestive tube aid digestion.

Exploration
10. The Digestive System

← H 155

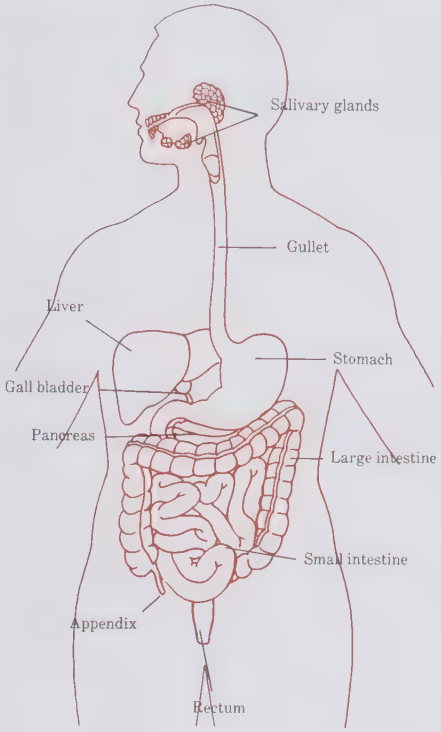
It is easier to understand the digestive system if you look at a picture. The tube is simple. But remember that digestive juices enter it, as well as food.

Today you will learn the parts of the body that make up the digestive system.

1-2. Part One The Long Tube

Study the diagram of the digestive system on this page. This is the tube that food passes through. Food is changed chemically on its travels through the tube.

Use a pencil or crayon to color in the digestive tube on the next page. Also, label the parts of the digestive tube.



Materials for Each Group

colored pencils

Time

Three days

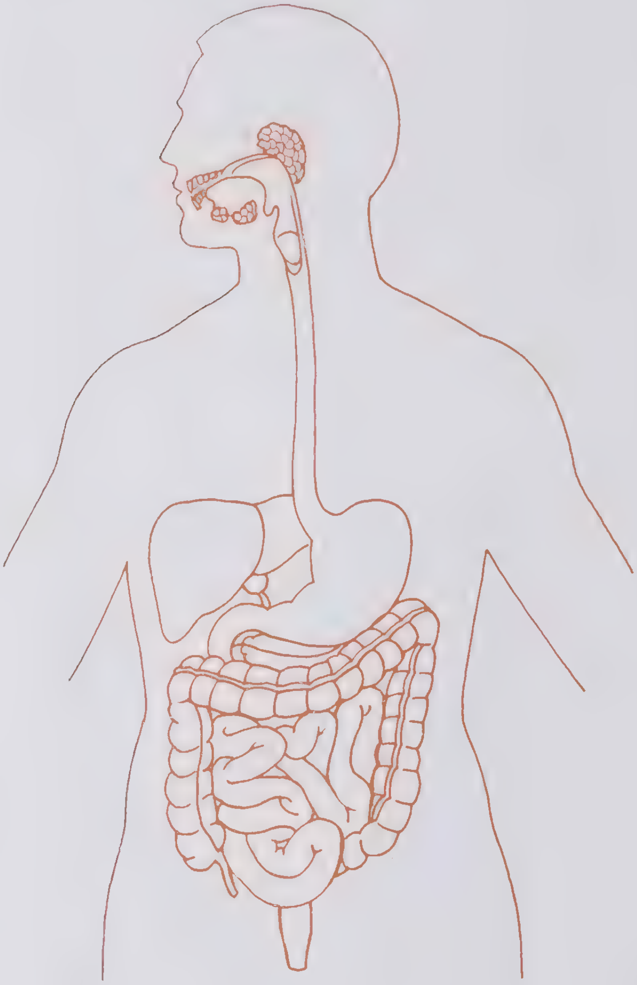
Parts One-Three

1. Charts and models of the digestive system should be in the room.
2. A torso that can be taken apart makes a good addition to this activity.

Hard cover users: To reproduce the illustration for the three glands in this Exploration please turn to page T 61 or direct students to the Laboratory Supplement.

3-4. Part Two The Three Glands

Three glands connected to the digestive tube send juices into it. Without these juices, digestion could not take place. They are the **salivary** (*SAL uh vehr ee*) **glands,** the **liver** and the **pancreas.** The **gall bladder** is attached to the liver. It stores one of the liver's juices before the juice passes into the digestive tube. Color in these glands on the drawing below. Then color the tubes that carry the juices from these glands into the digestive tube.



3. Memorizing the parts of the digestive system is not important here.

4. An understanding of the tube-like nature of the alimentary canal and the relationship of the glands to the tube are concepts we are looking for.

5. A piece of tripe from the butcher will illustrate the nature of the lining of the stomach. Point out how the surface of the lining is increased by the folds.

6. You can measure off 6 meters on the floor to illustrate the length of the small intestine.

5-6. Part Three The Digestive System

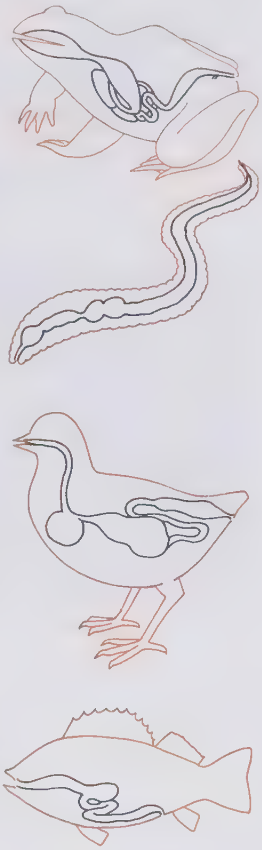
Where does the food go when it leaves the stomach? Into the small intestine. Some food diffuses into the blood.

Where does the unused material go when it leaves the small intestine? Into the large intestine. Much of it diffuses into the blood.

How does the juice from the pancreas get into the small intestine? Through a tube.

How does saliva get into your mouth? Through tubes from salivary glands.

How do these digestive systems compare to yours?



Check Yourself

1. What happens to food when it is digested? It is broken into small molecules.

2. Why is digestion necessary? The small molecules can pass through membranes into the blood.

3. The small intestine is about 6 meters long. How is such a long tube useful to the body? It holds the food long enough for digestion to be completed.

4. Where do you get the enzymes that you need for digestion? From the digestive glands.

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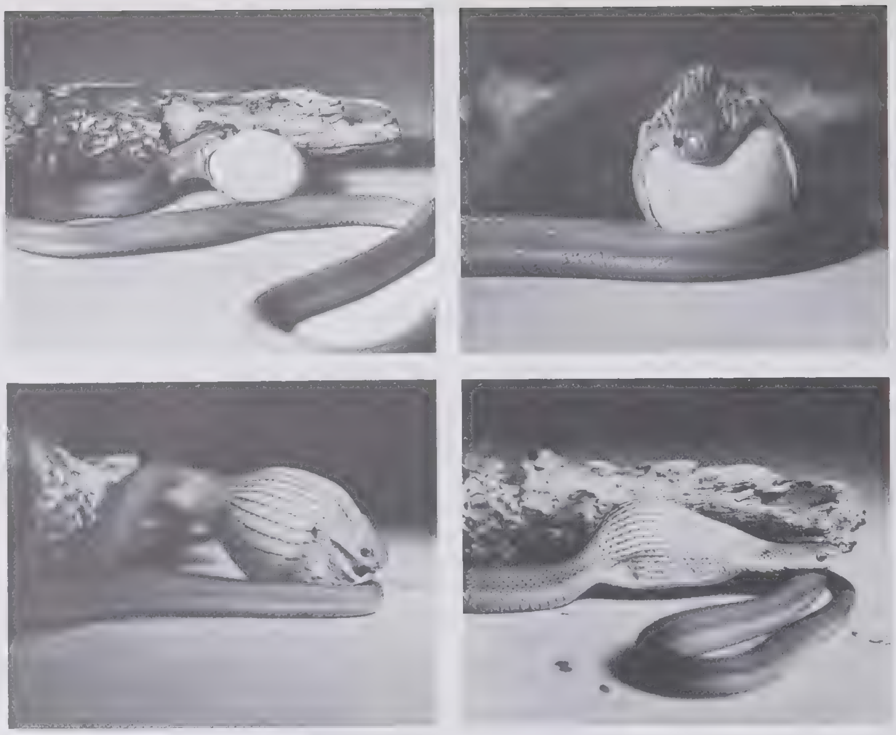


H 157

The amazing African egg-eating snake. It digests the inside of the egg and spits out the shell!

Research You Can Do

In 1822 Alexis St. Martin was wounded by a gun shot and was left with a big hole in his stomach. He allowed Dr. William Beaumont to look into this opening and study digestion for 11 years. Read about this unusual peephole in a book in your library.

Exploration 11. How An Enzyme Works

Overview

The workings of an enzyme are dramatized in this activity. Your approach to this exercise is all-important. Saliva must be collected and if one student balks, the whole class may balk. You should be able to get volunteers. Each group should collect saliva for each activity. The chemical reaction that the class will be studying is the change from starch to glucose.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) describe or define *enzyme.*

(2) tell how the enzyme in saliva aids digestion.

Materials for Each Group

funnel
3 test tubes
glass-marking pencils
rack for test tubes
Benedict's solution
thermometer
beaker (400 ml)

Time

Three days

1. Emphasize the fact that saliva is a digestive juice.
2. The number of groups you have will depend on how the class reacts to the idea of collecting saliva. However, don't let the class know you anticipate a problem.

Exploration
11. How An Enzyme Works

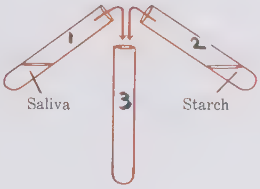
1. ENZYMES cause chemical changes in the body. They are important in the digestion of food. An easy digestive enzyme to work with is found in saliva. Today you will learn something about how it works.

2. Follow the directions carefully. Put a check (√) next to the number after you finish each step.

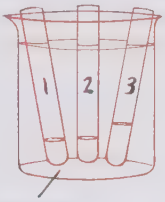
3-4. ( ) 1. Put a funnel into a test tube and collect about 2 cm of saliva. (Be sure that the person who gives the saliva has not been chewing gum or eating or smoking.) Mark the test tube No. 1 with a wax pencil. Set it in a rack.

( ) 2. Put about 2 cm of a starch mixture in a test tube. Mark it No. 2 with a wax pencil.

( ) 3. Get another clean test tube. Put in it about 1 cm of the saliva from tube No. 1 and about 1 cm of the starch mixture from tube No. 2. Shake the tube for a minute. Mark it No. 3.



5. ( ) 4. Place the three test tubes in warm water. Keep the water as close to body temperature as possible. Leave the test tubes in the warm water for 10 minutes.

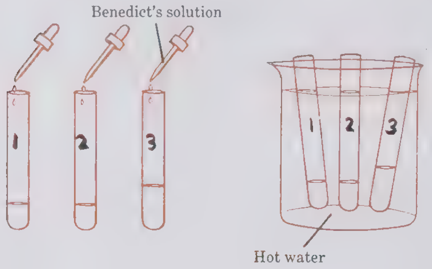


3. Sometimes students will collect saliva if they are permitted to go out into the hall or somewhere that is more private than the class area.
4. To increase the flow of saliva and make it easier to collect, the student-donor can chew on a clean rubber band or a piece of clean paraffin.
5. A thermometer in the beaker will help you keep it at 98.6°F.

Reminder: Order hearts for Chapter 7, Exploration 2.

( ) 5. Now you are going to find out if there is any glucose in the test tubes. Add 20 drops of Benedict's solution to each tube and place the tubes in hot water.

Let them stay in the hot water until there is a color change in at least one of the tubes. Remember that an orange color means you have glucose. A green color means you have just a little glucose.



Now analyze what you have done. Answer these questions.

What did you put in test tube No. 1? Saliva.

Does test tube No. 1 have any glucose in it now? No.

What did you put in test tube No. 2? Starch.

Does test tube No. 2 have any glucose in it now? No.

What did you put in test tube No. 3? Starch and saliva.

Does test tube No. 3 have any glucose in it now? Yes.

What do you think happened in test tube No. 3? Enzyme in saliva changed starch to glucose.

What do you think is the control? Starch alone and saliva alone.

Write a statement that will tell how the enzyme in saliva is important in digestion. It changes starch (a large molecule) to glucose (a smaller molecule).

Check Yourself

1. What large molecule does the enzyme in saliva change? Starch.

2. What is an enzyme? A substance that causes a chemical change in the body.

3. What are some of the large food molecules that must be changed by enzymes? Starch, proteins, fats.

4. Why must these large food molecules be changed by enzymes? Large molecules cannot pass through cell membranes.

Research You Can Do

Plan a test to find out if the enzyme in saliva will work at a very high temperature. Remember to include a control. If you can, do the test and keep a record of what happens.

Plan a test to find out if the enzyme in saliva will work at a very low temperature. Remember to include a control. If you can, do the test and keep a record of what happens.

Plan a test to find out if the enzyme in 1 cm of saliva is used up as it changes starch to glucose. If you can, do the test and keep a record of what happens.

← H 160

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 39 or direct students to the Laboratory Supplement.

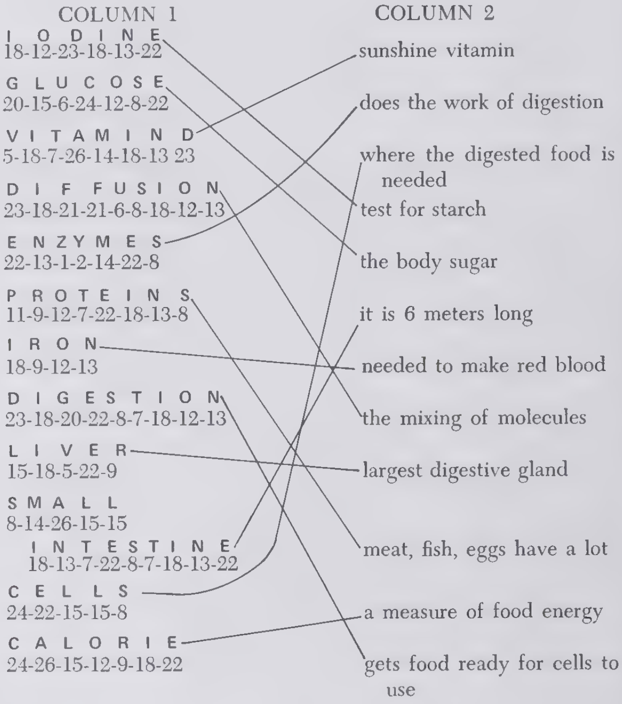
Use Your Wits!

HERE is a number code. Each number stands for a different letter. Use this code to find out what the secret words in column 1 are. Write each letter over the number in the code word. Then, draw a line between each word in column 1 and the term in column 2 that matches it best.

CODE

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Z	Y	X	W	V	U	T	S	R	Q	P	O	N	M	L	K	J

18	19	20	21	22	23	24	25	26
I	H	G	F	E	D	C	B	A



COLUMN 1

IODINE
18-12-23-18-13-22

GLUCOSE
20-15-6-24-12-8-22

VITAMIN D
5-18-7-26-14-18-13 23

DIFFUSION
23-18-21-21-6-8-18-12-13

ENZYMES
22-13-1-2-14-22-8

PROTEINS
11-9-12-7-22-18-13-8

IRON
18-9-12-13

DIGESTION
23-18-20-22-8-7-18-12-13

LIVER
15-18-5-22-9

SMALL
8-14-26-15-15

INTESTINE
18-13-7-22-8-7-18-13-22

CELLS
24-22-15-15-8

CALORIE
24-26-15-12-9-18-22

COLUMN 2

sunshine vitamin

does the work of digestion

where the digested food is needed

test for starch

the body sugar

it is 6 meters long

needed to make red blood

the mixing of molecules

largest digestive gland

meat, fish, eggs have a lot

a measure of food energy

gets food ready for cells to use

7 The Circulatory System

← H 161

H 162

Reading
1. The Heart and Blood Vessels

Relax — Squeeze — Relax — Squeeze — Relax — Squeeze. From long before you are born to the instant you die. Relax — Squeeze. The beat of your heart as it pumps your blood to all the cells in your body. Relax — Squeeze — Relax — Squeeze.

1. Put your hand over your heart. Can you feel it beat?

The heart muscle is different from the other muscles in your body. It cannot ever stop working. This pump beats about 72 times a minute, every minute of your life. Even if it is damaged, it cannot rest. It must keep beating to keep the blood flowing through your body.

2-3. Your heart is about the size of a fist. It is divided into four parts called **chambers**. Each side of the heart is a pump with an upper and lower chamber. You could think of the heart as two pumps working together.

The lower chambers pump blood out of the heart. The upper chambers collect the blood that returns to the heart. Because they work harder, the lower chambers have thicker muscle walls.

Reading 1. The Heart and Blood Vessels

1. Don't let the students accept the number 72 as a hard and fast figure. It is an accepted average. However, the heartbeat is faster in young children.

2. The term "coronary" for a heart attack may be familiar to the students. Mention this when they read about the coronary arteries.

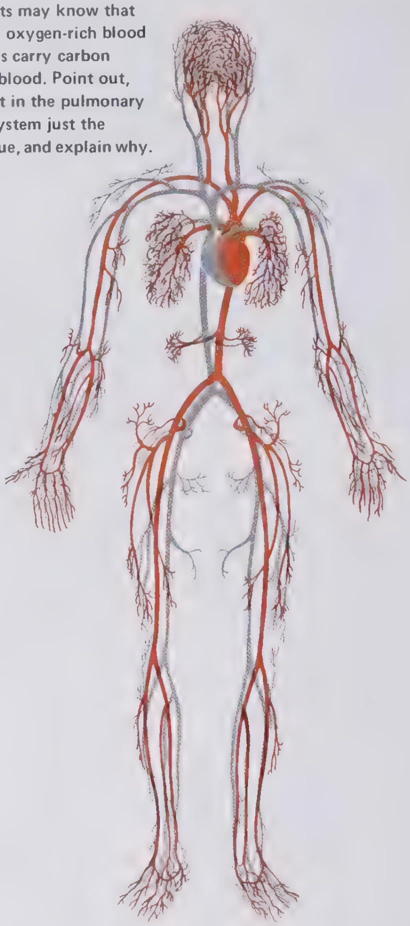
3. The heart is tilted to the left and it is easier to feel the beat a little left of center.

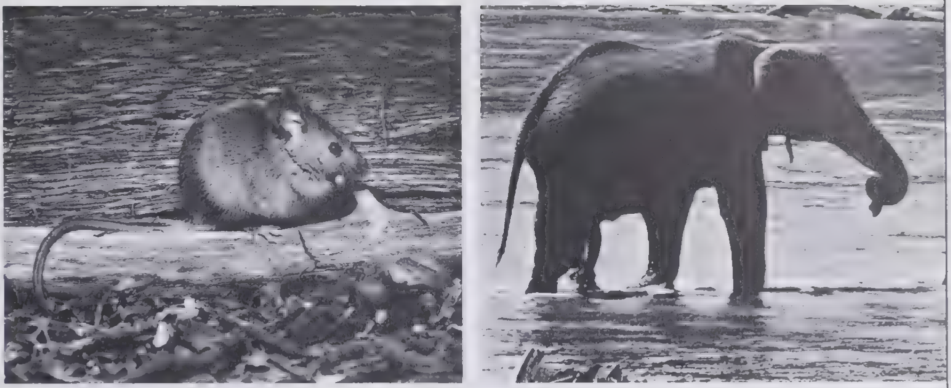
The heart has a set of one-way doors called **valves**. The valves keep the blood moving in one direction. They open to let the blood flow from the upper to the lower chambers. Then they close to keep the blood from flowing back again. You can hear the valves snap shut if you listen to your heart with a **stethoscope** (*STEHTH uh skohp*).

Blood pours into the heart and surges out of it through the **blood vessels**. Blood vessels go to and from every part of your

The human circulatory system. The brown blood vessels carry oxygen-rich blood. The gray blood vessels carry carbon dioxide-rich blood.

Some students may know that arteries carry oxygen-rich blood and that veins carry carbon dioxide-rich blood. Point out, however, that in the pulmonary circulatory system just the opposite is true, and explain why.





The biggest isn't the fastest. A mouse's heart beats about 700 times a minute. But an elephant's heart beats only 25 times a minute.

body. The blood takes food and oxygen to the cells and carries carbon dioxide and other wastes away from the cells.

← H 165

There are three kinds of blood vessels: **arteries** (*AHR tuhr ees*), **veins** (*VAYNS*), and **capillaries** (*KAP uh* LEHR *ees*).

Large arteries carry blood away from the heart. These arteries branch into smaller arteries. And the smaller arteries branch into even smaller arteries, until they connect to the smallest blood vessels, the capillaries.

4. Each capillary is thinner than a hair. Food and oxygen in the blood can pass through the thin capillary walls into the cells. Wastes from the cells travel in the opposite direction. Wastes go from the cells — through the thin capillary walls — into the blood stream.

The capillaries connect to very small veins. The small veins connect to bigger veins. Blood finally returns through the biggest veins to the right side of the heart. From there it is pumped through arteries to the lungs.

There are two round trips for blood. One is from the heart → to the parts of the body → to the heart. The other round trip is from the heart → to the lungs → back to the heart.

In the lungs, the carbon dioxide in the blood is exchanged for fresh oxygen. The oxygen-rich blood from the lungs flows back to the heart. Then it is pumped out through big arteries, and travels through the whole body. Oxygen-rich blood and carbon dioxide-rich blood never mix inside the heart.

4. We're talking about diffusion again and it takes place through the walls of the capillaries.

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5-7. Special arteries go around the heart itself. They are known as the **coronary arteries** (*KAWR uh nehr ee AHR tuhr ees*). The heart muscle gets its own food and oxygen from the blood in the coronary arteries.

You can learn more about the coronary arteries and your heart in *Lifeline* by Leo Schneider.

This person had her damaged heart valve replaced with an artificial valve. Can you see where it is? Can you see where her chest was opened up and later stitched up?

5. Make use of the illustrations and captions. Stop and discuss any of them that may not be clear to the class.

6. The illustrations that compare humans with other animals will give the students a chance to make comparisons, but don't ask them to memorize any differences.

7. Emphasize the fact that the cell is the place where food and oxygen are used. The blood takes food and oxygen to the cells.

Exploration 2. A Look at the Double Pump

Overview

This Exploration should follow the background Reading "The Heart and Blood Vessels." Be certain that the class understands that the heart is a double pump and that the pump needs a good supply of blood. The class can hypothesize about the size of each ventricle, about valves and about fat on the heart.

Behavioral Objectives

After completing this Exploration, the students will be able to

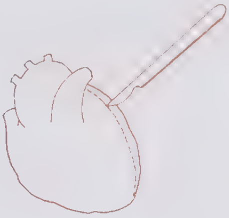
(1) explain the structure of the heart and name its major parts.

(2) explain the function of the heart.

Exploration

2. A Look at the Double Pump

HAVE YOU ever seen a heart? Today you will study one that comes from a large animal. Your teacher will give you a heart from a cow, pig, or lamb.



Part One A Heart a Lot Like Yours

1. To see the parts of the heart, you have to cut it open. Look at the drawing to see where to make the cut.

What kind of animal's heart is this? Answers will vary.

How many chambers does this heart have? Four.

How are the upper chambers different from the lower chambers? Upper chambers are thin-walled and look like flaps. Lower chambers are larger, thick-walled, muscular.

Find the valves between the upper and lower chambers. What do they look like? White, tough, stringy.

Can you find the large blood vessels that carry blood to and from the heart? Yes. (At least some of them.)

The largest blood vessel is the **aorta** (*ay AWR tuh*). It is an artery that carries blood from the lower left chamber of the heart. The aorta branches into smaller arteries that go to all of the parts of the body.

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Materials for Each Group

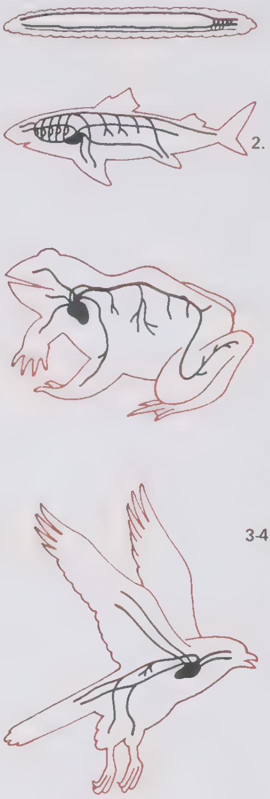
fresh hearts (cow, lamb, pig)
dissecting pan
dissecting tools (scalpels)
large sharp knife
red pencils

Time

Two days

1. Part One A fresh lamb or pig heart can be secured from a slaughterhouse or from a butcher. Order it two or three days ahead of time. Sometimes it is possible to get a heart and lung combination. One heart can be used for several classes.

How do these circulatory systems compare with yours?



What does this large vessel look like? Thick-walled, tough, elastic, creamy white.

Are there any blood vessels on the surface of the heart? Yes.

2. Why would the heart muscle itself need coronary arteries and veins? To carry food and oxygen to the heart and carry waste away.

Is there any fat on the surface of the heart? Yes. Think of a reason why too much fat on the heart would be harmful. The weight of the fat puts a strain on the heart.

3-4. Part Two Your Circulatory System

Study the diagram of the human heart on the next page and label the following parts:

a. **right atrium** (*AY tree uhm*) and **left atrium**. These are the upper chambers.
b. **right ventricle** (*VEHN trih kuhl*) and **left ventricle**. These are the lower chambers.
c. valves
d. the artery that carries blood to the lungs
e. veins that carry blood from the lungs
f. the aorta
g. veins that carry blood to the heart from all parts of the body

Color the diagram of the heart. Use dark red to color the side of the heart that pumps blood with a lot of carbon dioxide in it. Use light red to color the side of the heart that pumps oxygen-rich blood.

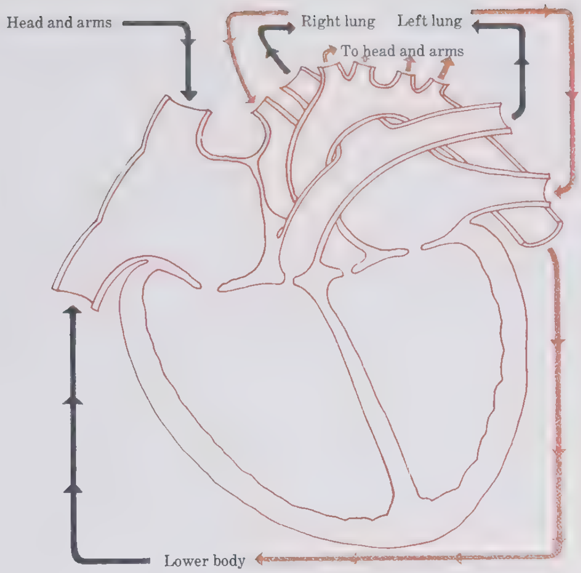
2. Here is a good place to point out complementarity of structure and function.

3. **Part Two** Using dark red coloring for blood with carbon dioxide and lighter red for oxygenated blood is in keeping with the trend away from using blue coloring for blood with carbon dioxide.

4. Don't strive to have students memorize the path of blood. Try to help students understand the need for pulmonary circulation and the importance of maintaining an efficient circulatory system.

Reminders: If you have a heart-lung combination that is still in good condition when this lab is completed, freeze it for use in Chapter 8, "The Breathing System."

Your county or state branch of the American Heart Association is a good source of films, charts, and other material for the students. Be sure to order the films as early as possible.



Hard cover users: To reproduce the illustration of the heart for this Exploration please turn to page T 62 or direct students to the Laboratory Supplement.

Check Yourself

1. What is the job of the arteries? To carry blood from the heart to parts of the body.

2. What is the job of the veins? To carry blood back to the heart.

3. Why are capillaries important? They connect veins and arteries. Diffusion takes place in the capillaries.

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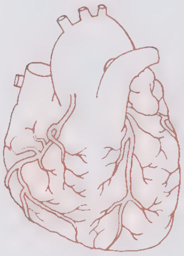
4. Can you think of a reason why the walls of the ventricles are thicker than the walls of the atriums? They are the pumping chambers and need more muscles.

5. How do valves help to keep the blood flowing through the heart? They close if the blood tries to go in the wrong direction.

6. There are valves inside the veins. How could they help the flow of blood from your feet to your heart? By preventing the blood from dropping back toward the feet.

Hard cover users: To reproduce the illustration of the heart for this Exploration please turn to page T 62 or direct students to the Laboratory Supplement.



7. Color in the coronary arteries in this diagram. One of these is blocked. So don't color in the parts that blood can't get to.

8. What do you think will happen to the part of the heart that can't get its blood supply? It will be damaged because it will not get food or oxygen.

Exploration 3. How Fast Does Your Heart Beat?

Overview

The students will have fun finding their own pulse rates in this Exploration. They will record their own pulse rate and the average pulse rate of the class. A few students will need help in tabulating averages. Try to get most of the students to use a stethoscope to listen to their hearts, too. Many of them will enjoy being "doctor."

Behavioral Objective

After completing this Exploration, the students will be able to

(1) identify some factors that will change pulse rate.

Materials for Each Group

stopwatch or clock with second hand
stethoscope (optional)
cotton
alcohol

Time

Two days

1. Part One The students may need help finding the pulse. Be sure that each student is able to get a pulse count before timing begins.

2. There may be a wide range of pulses when you list them on the chalkboard. Remember to point out that it is easy to miscount and that pulse rates vary considerably

Exploration

3. How Fast Does Your Heart Beat?

EACH TIME your heart beats, blood is forced into the arteries. Each gush of blood is so fast and strong that it stretches the artery walls as it goes through the arteries. When a doctor takes your pulse, he counts the number of beats (or stretches) in one minute.

You can find your own pulse. Place the fingers of your right hand on the inside of your left wrist, just above the thumb. Be sure to use your fingers, not your thumb. Press down. You are feeling an artery in your wrist. You can feel it stretch every time your heart beats.

Part One The Average Pulse Rate

1. Your teacher will tell you when to start. Count the number of times your pulse beats in one minute.

   How many times did your pulse beat in one minute? Varies.

2. Have someone list each person's pulse rate on the chalkboard. You list them in the space below.

   Students record data.

3. Now you can find the average pulse rate of the class.

   Add all the pulse rates together. Students record information.

   Count the number of students in the class. ______

   Divide the total of the pulse rates by the number of students. ______

   This is the average pulse rate for the class.

within the norm. We use 72 as an average figure. Stress the fact that an average includes highs and lows, and that this average is for adults.

3. Adding the numbers together will take a few minutes. One or two students may work at the board while the rest work at their seats.

The average pulse rate for people is 72 times a minute. How do you think doctors got this number? By taking the average pulse rate of thousands of people.

Is the average rate for your class 72 times a minute? Varies.

If it isn't, think of some reasons that might explain the difference. Get ideas from everyone in the class. The sample is small, everybody is young, inexperience in taking a pulse, for example.

4. Part Two Upbeat

Jump up and down 20 times. Now sit down and take your pulse for one minute. (Don't do this part of the lesson if you are a person who is not supposed to do a lot of exercise.)

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What is your pulse rate now? Students record data.

Why do you think your pulse rate changed? Your cells need more oxygen for exercise, and that means a faster heartbeat.

Did everyone's pulse rate change? Answers vary.

5-7. Part Three Listen to Your Heart

Use a stethoscope to listen to your own heart (or your partner's heart). Be sure to wipe the ear pieces clean with alcohol after

4. **Part Two** Ask the students if their pulse rates would double if they jumped up and down 40 times.

5. **Part Three** If two or three stethoscopes are available, use all of them. Even a toy stethoscope will pick up the heartbeat. If a student has trouble finding the heartbeat, tell him to use the pulse at the throat, between the collarbones.

6. Occasionally a student doesn't want to listen for a heartbeat. Don't insist, some students find it a little scary. They may want to try it later in the period.

7. Make it a point to keep stethoscopes clean.

Reminder: Arrange for outdated blood for Exploration 6, if it will be needed.

This machine is connected to four people with heart problems. The jagged lines on the screen are pictures of their heartbeats. If a person's heart begins to fail, the nurse will know at once.

each use. Describe the sound of your heart. Let students describe.

What do you think a doctor can learn by listening to your heart?

He can detect malfunctions like heart murmur or irregular beat.

Check Yourself

1. What is a pulse? The stretching of an artery wall as the heart beats.

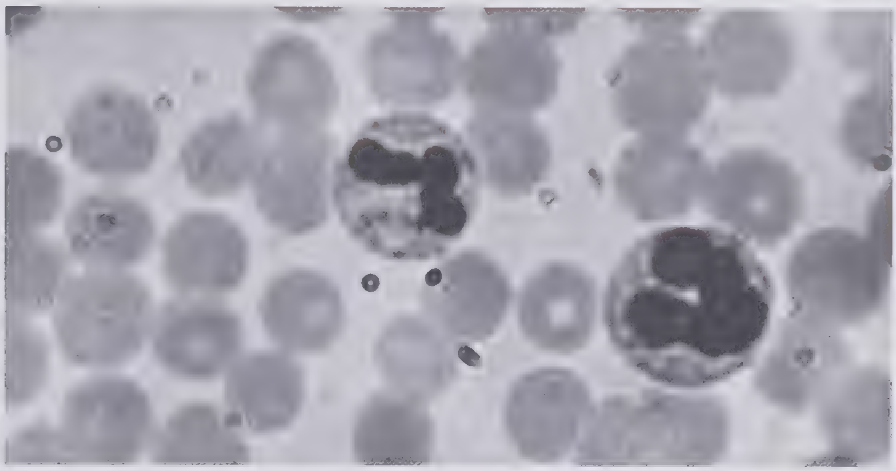
2. Can you find a pulse any places besides the wrist and the neck?

Upper arm, ankle, groin, and jaw, among others.

3. What are some things that might change the pulse rate?

Exercise, illness, fear, sleep, age, excitement, and others.

4. When you take your pulse, what kind of blood vessel are you feeling? Artery.



Red and white blood cells in a healthy person

1-3. YOUR BLOOD is a salty stream. It carries materials to and from the cells in the body. There are two kinds of cells in the blood: red cells and white cells. The job of white cells is to eat germs. The red cells pick up oxygen in the lungs. Then they carry it to all parts of the body.

Red blood cells are made in the soft centers of the bones. These cells wear out after about 120 days of tossing and tumbling along in the blood vessels. So new red cells have to be made all the time to replace the old ones.

Human red blood cells are not like other cells. They don't have a nucleus. They do have a chemical called **hemoglobin** (*HEE muh* CLOH *buhn*). Hemoglobin's job is to carry the oxygen from the lungs to all the cells in the body.

Iron is an important part of hemoglobin. You need to eat foods
4. that are rich in iron. If you do, your body can make enough
hemoglobin. If you don't, your blood can't carry enough oxygen
to your cells.

Reading 4. The Stream of Life

1. White cells "eat" germs by engulfing them.

2. Students may have the notion that blood in the veins is blue. This idea is sometimes reinforced by charts and models that have printed the veins with blue coloring. The students may have looked at veins through the skin of the hand and observed a blue tint.

3. Anyone who has ever put a cut finger to his or her mouth knows that blood tastes salty.

4. Does anyone remember what foods are a good source of iron?

When the hemoglobin is carrying a lot of oxygen, the blood is bright red. So the blood in your arteries is usually bright red. After the hemoglobin gives up its oxygen to the cells, the blood turns dark red. So the blood in your veins is usually dark red. The blood in your veins may look blue, but no vertebrate has blue blood. Not even you.

White blood cells are much larger than red blood cells. They do have a nucleus, and they live for only a few days. There are about 600 times more red cells than white cells.

White blood cells are the germ fighters in the body. When disease germs get into your body, that's called an **infection** (*ihn FEHK shuhn*). The white cells leave the bloodstream to attack the infection. They can even move upstream. They eat germs and bits of dirt, then die. You have probably seen dead white cells. They are part of the pus that collects around a wound.

The body makes extra white blood cells to help fight infections. One way to tell if someone has an infection is to take a sample of his blood. A technician can use a microscope to count the number of white blood cells in a drop of blood. He knows how many white blood cells there usually are. If there are a lot more white blood cells than usual, the person probably has an infection.

5. If you take out the red and white blood cells, the rest of the blood is mostly water. This part of the blood is called **plasma** (*PLAZ muh*). The plasma carries the blood cells. It also takes dissolved food to body cells and wastes from the cells. When the skin is cut, another chemical in the plasma forms a clot. This clot acts like a plug and stops the bleeding.

When you get a cut, a blood clot forms to keep all the blood from pouring out of your body. Chemicals in the blood form a net of fibers over the cut. The net traps red blood cells. The net and the trapped cells make up the clot.

5. Plasma is a complex substance. It contains hormones, vitamins, wastes, salts, and products of digestion.

Exploration 5. What Does Blood Look Like?

Overview

Your students will enjoy observing blood cells as they flow through the tail of a fish. Careful observations will show red blood cells moving in two directions. Students will also see differences in rate of flow and in the size of blood cells. Looking at human blood under the microscope will be more meaningful after this activity.

Behavioral Objectives

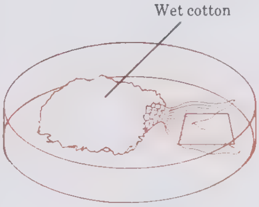
After completing this Exploration, the students will be able to

(1) verify that blood flows by observing the blood flow in a fish's tail.

Exploration
5. What Does Blood Look Like?

Today you will have the chance to see blood cells flowing through a living animal. Then you will look at slides of blood cells.

Part One Watching Blood Flow



1. The animal you will use is a goldfish. You can look through its thin tail with a microscope. You won't hurt the fish if you keep it wet and handle it carefully.
2. Wrap the fish in wet cotton, but leave its tail uncovered. Put the fish in a petri dish and place a cover slip on its tail.

Remove the clips from your microscope. Then put the dish on the stage. The tail should be over the opening in the stage. Focus on the tail with the low power lens. If the fish moves while you are watching it, you may have to wipe off the lens and focus all over again.

Spend a few minutes watching the flow of blood. Then answer these questions:

3. Can you see cells moving through the blood vessels? Yes.

The cells that you see are red blood cells. What do they look like?

Disk-like, small, gold in color.

In how many different directions is the blood flowing? Answers will vary.

Why do you think this is important? To get blood to the tail and back to the heart.

Look for a blood vessel that is carrying blood toward the head. Is it a vein or an artery? Vein. Give a reason for your answer.

Blood going toward the head is going toward the heart.

(2) distinguish between veins and arteries.
(3) explain functions of red blood cells and at least one function of white blood cells.

Materials for Each Group

goldfish
cotton
petri dish (top or bottom)
coverslip
microscope
permanent slide of human blood

Time

Two days

1. Part One Students will show some concern for the well-being of the fish. The fish can be kept out of water about twenty minutes without harming it. However, if this activity is done with more than one class, use a different fish for each. Also, if you notice that the circulation of blood is slowing down while the tail is being observed, it will be best to put that fish back in the tank and use another.

2. Try to get a student to point out that we use a fish tail in this lesson (and not a student's toe) because it is thin and transparent. Remember the microscope lesson.

3. If you focus on a capillary, you can see red blood cells moving through it in single file.

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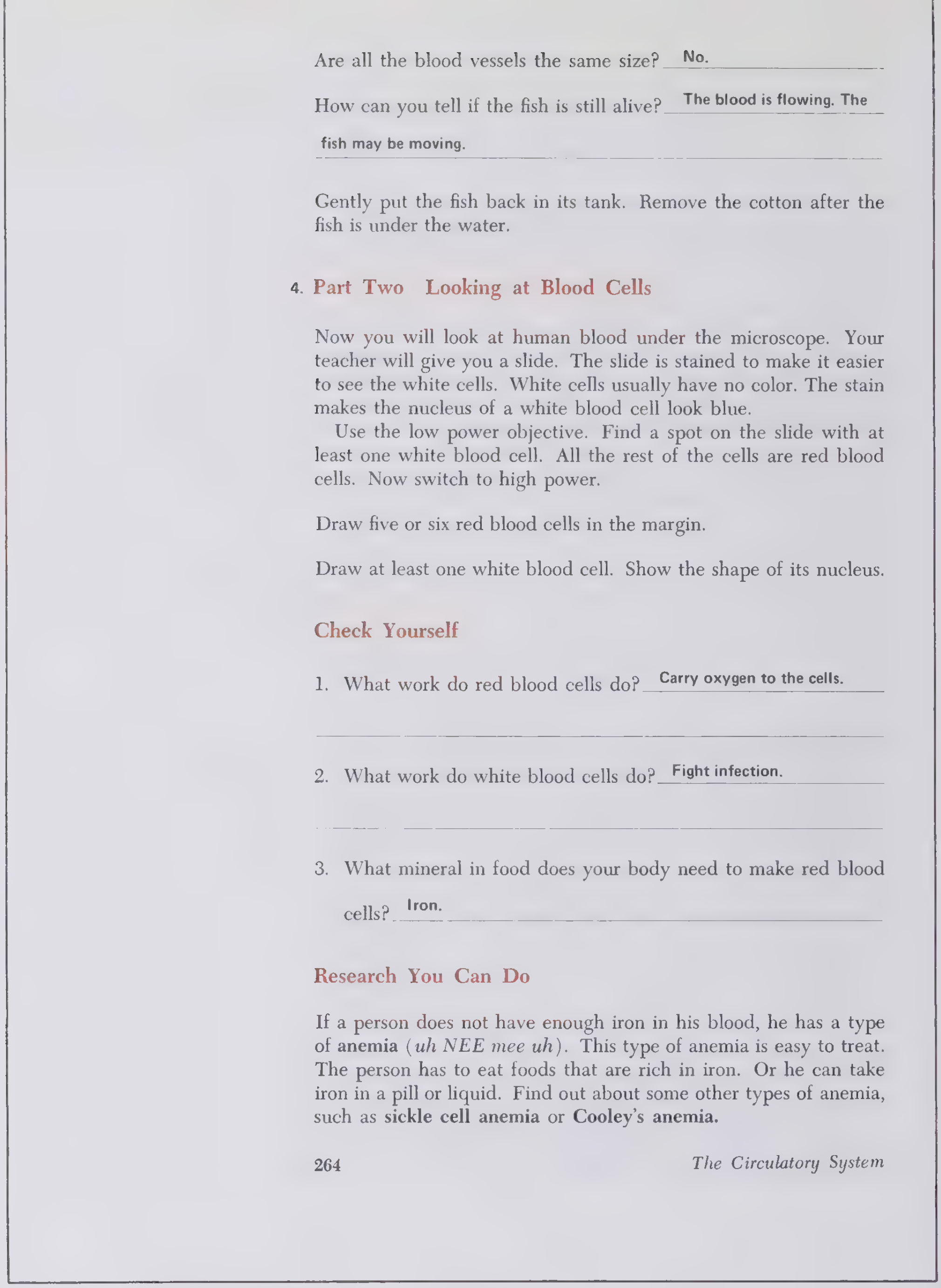

Are all the blood vessels the same size? No.

How can you tell if the fish is still alive? The blood is flowing. The fish may be moving.

Gently put the fish back in its tank. Remove the cotton after the fish is under the water.

4. Part Two Looking at Blood Cells

Now you will look at human blood under the microscope. Your teacher will give you a slide. The slide is stained to make it easier to see the white cells. White cells usually have no color. The stain makes the nucleus of a white blood cell look blue.

Use the low power objective. Find a spot on the slide with at least one white blood cell. All the rest of the cells are red blood cells. Now switch to high power.

Draw five or six red blood cells in the margin.

Draw at least one white blood cell. Show the shape of its nucleus.

Check Yourself

1. What work do red blood cells do? Carry oxygen to the cells.

2. What work do white blood cells do? Fight infection.

3. What mineral in food does your body need to make red blood cells? Iron.

Research You Can Do

If a person does not have enough iron in his blood, he has a type of **anemia** (*uh NEE mee uh*). This type of anemia is easy to treat. The person has to eat foods that are rich in iron. Or he can take iron in a pill or liquid. Find out about some other types of anemia, such as **sickle cell anemia** or **Cooley's anemia.**

4. Part Two This, too, can be handled as a demonstration if you wish. Although permanent slides may be used, students do like to look at their own blood, if it is permitted by your school system.

To make a fresh slide:

Swab the finger to be used with 70% alcohol. Use a sterile lancet to draw two small drops of blood. Place them on one end of the slide. Push the end of another slide into the blood and draw it back to spread it into a thin layer.

Flood the slide with Wright's stain while it is suspended on two supports. After one and one-half minutes, add distilled water drop by drop until the slide won't hold any more liquid. After one and one-half minutes, rinse in tap water. Allow the slide to dry, and then set it under the high power objective of the microscope. The white blood cells will be stained blue.

Reminder: Order lungs for Chapter 8.

Exploration
6. How to Type Blood

1-2. THERE ARE four blood types. Everybody is born with one type of blood: type **A**, type **B**, type **AB**, or type **O**. Your type is important if you need a blood transfusion. You must be given blood that matches your type.

Your job today is to type blood. This will help you understand why blood types must be matched for a transfusion. You may be able to type your own blood today.

Exploration 6. How to Type Blood

Overview

As a rule the class will enjoy typing their own blood. You probably had difficulty preventing them from drawing blood with a pin in the last activity. Impress upon them the necessity of using a sterile technique, of following directions, and of using care in their work. A little assistance might be needed in interpreting the chart but you will find that some students will become experts.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) prepare slides for blood typing.

(2) identify blood types by observing the slides.

Materials for Each Group

slides
blood typing serum
alcohol
cotton
sterile lancets
toothpicks

Time

Two days

1. If your school system does not permit the students to type their own blood, it is possible to use outdated blood from a hospital. If you plan to do this, make your arrangements a few days ahead. In fact, it is a good idea to have

You will use two substances made from human blood: anti-A serum and anti-B serum. If you mix anti-A serum with type A blood, the blood clumps up. If you mix anti-B serum with type B blood, that blood clumps up. That's easy to remember — anti-A clumps A, anti-B clumps B.

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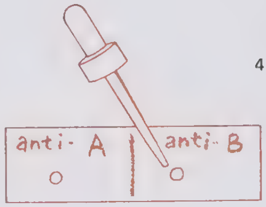
3. Type AB blood clumps with either serum. Lastly, type O blood does not clump with either serum. Remember them this way — AB always clumps, but type O does nothing.

Check off each step after you do it.



4. ( ) 1. Get a clean glass slide. Use a wax pencil to draw a line down the middle. Mark the left side of the slide *anti-A*. Mark the right side *anti-B*.

( ) 2. Put a drop of anti-A serum on the left side of the slide. Put a drop of anti-B serum on the right side.

( ) 3. Add a drop of blood to each drop of serum.

( ) 4. Use a different clean toothpick to stir each drop of blood into its drop of serum.

( ) 5. Set the slide aside for five minutes. Then look to see if the blood formed clumps with the serum or mixed freely.

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Did the blood on your slide mix or clump with the anti-A serum?

Students describe.

Did the blood on your slide mix or clump with the anti-B serum?

Students describe.

Use the diagram on the next page to find out what type of blood you used. Circle the type.

Where did you get the blood that you used? ______

Answers will vary.

Did everyone in the class have the same results? **No. Results vary.**

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5. If members of the class used their own blood, find out how many have each type of blood.

Type O ______ Type B ______

Type A ______ Type AB ______

outdated blood on hand if it is available. (Such blood has been stored beyond the time it can be used for transfusion.) The class can see how it is packaged and marked. It might be used as an unknown for any student who wants to do more with this laboratory lesson.

Cover the label if the class uses the hospital's blood. As each student finishes, let him or her peek to check results.

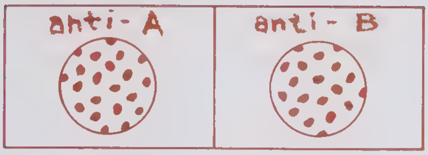
2. No pressure should be put on students who do not wish to do this activity.

3. Some student may want you to puncture his or her finger to draw blood. If someone does, make sure he or she swabs the finger with alcohol.

4. It is easier and more economical if the teacher or a careful student puts the drops of serum on the slides.

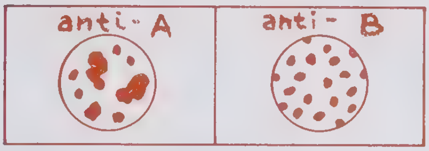
5. Be sure that the class doesn't get the idea that one blood type is better than another.

If your
slide looks
like this



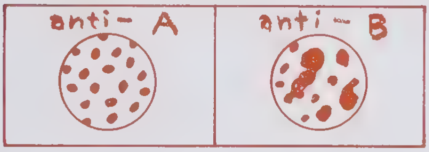
Your blood is Type O.

If your
slide looks
like this



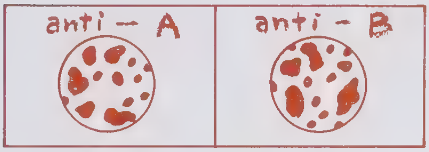
Your blood is Type A.

If your
slide looks
like this



Your blood isType B.

If your
slide looks
like this



Your blood is Type AB.

Check Yourself

1. Name the four types of blood. A, B, AB, O.

2. Type O is the most common type of blood in the United States.

What is the most common type of blood in the class? (You can answer this only if the class members used their own blood.) Answers will vary.

3. Look at the table. Can a person with type A blood donate blood to a type O person? No.

Donor (gives blood)

Receiver (gets blood)	*A*	*B*	*AB*	*O*
A	*yes*	*no*	*no*	*yes*
B	*no*	*yes*	*no*	*yes*
AB	*yes*	*yes*	*yes*	*yes*
O	*no*	*no*	*no*	*yes*

4. Why are people with type O blood called universal donors?

They can donate to all types (although doctors prefer to match types).

5. Why are people with AB blood called universal receivers?

They can receive blood from all types.

Research You Can Do

6. The **Rh factor** is a chemical in blood that is important in blood transfusions. About 85 percent of all people have this factor in their blood. They are called Rh+ (positive). The 15 percent that do not have this chemical are Rh− (negative). Find out what happens when an Rh negative woman is pregnant with an Rh positive baby.

Blood can be stored in a **blood bank** until it is needed for a transfusion. Whole blood contains living cells and must be kept in a refrigerator. It can't be used after a few weeks. Plasma can be dried and kept for years. Find out about Charles Drew, an American scientist. He helped set up the first blood bank.

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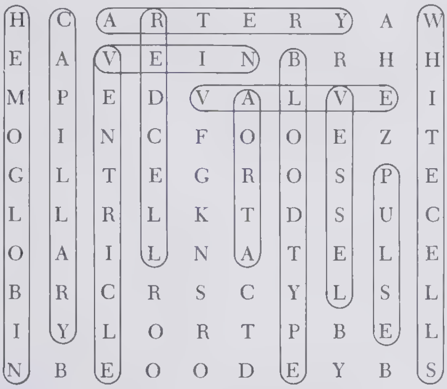
6. Encourage a few students to do the research on Dr. Charles Drew.

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 40 or direct students to the Laboratory Supplement.

There are words hidden in the puzzle. All the words have to do with circulation. Some words are going across and some are going down in the puzzle. Find as many as you can and draw lines around them.



H	C	A	R	T	E	R	Y	A	W
E	A	V	E	I	N	B	R	H	H
M	P	E	D	V	A	L	V	E	I
O	I	N	C	F	O	O	E	Z	T
G	L	T	E	G	R	O	S	P	E
L	L	R	L	K	T	D	S	U	C
O	A	I	L	N	A	T	E	L	E
B	R	C	R	S	C	Y	L	S	L
I	Y	L	O	R	T	P	B	E	L
N	B	E	O	O	D	E	Y	B	S

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8 The Breathing System

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H 180

Hard Cover Folios Preceded by H

1. The Air You Breathe

1. PEOPLE on the moon or under the sea have to carry oxygen with them. If they did not, they would die in a few minutes. Without oxygen, you, too, would live only a short time.

About one fifth of the air you breathe is oxygen. The rest is mostly nitrogen, and small amounts of other gases, such as carbon dioxide. Your body takes the oxygen it needs from this mixture of gases.

Reading 1. The Air You Breathe

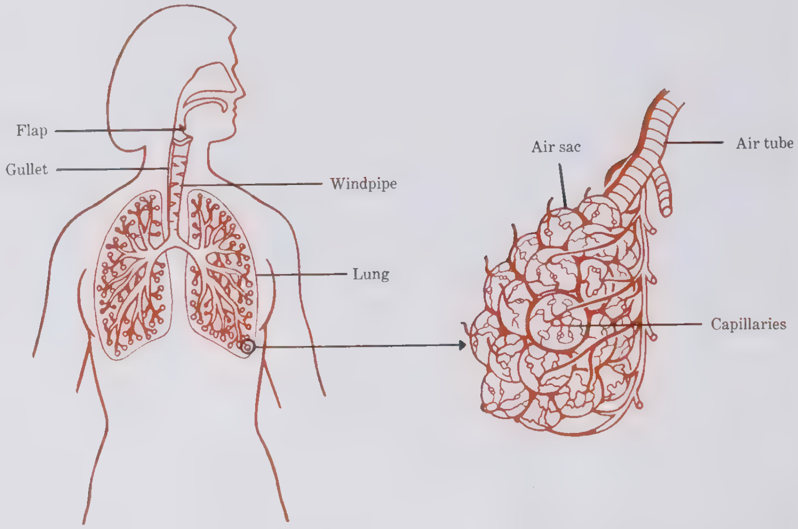
1. Remember to emphasize that the cell is where the oxygen must be used.

2. The air you breathe goes down your **windpipe** into your **lungs**. In the lungs the air passes into smaller and smaller tubes. Finally, the air comes to a dead end — an **air sac**. Air sacs are like microscopic balloons. The lungs contain millions of air sacs. And each air sac has capillaries around it.

The oxygen in the air diffuses into the capillaries around the air sacs. At the same time carbon dioxide moves out of the blood into the air sacs. The carbon dioxide leaves the body as you breathe out. This is the job of your breathing system — getting oxygen into the blood and carbon dioxide out of the blood.

The opening to the windpipe is at the back of the throat. But the opening of the gullet is at the same place. There is a flap over the windpipe opening to keep food out. It closes off the windpipe when you swallow so that food will not go down the wrong tube. You can't breathe and swallow at the same time. Sometimes a bit of food does slip by the flap and get into the windpipe. Then you begin to cough. This pushes the food back into your mouth and protects the lungs from damage.

3. Your breathing system has a built-in cleaning system. Hairs in your nose catch some dirt in the air. Also, the large air tubes from the nose to the lungs have a sticky lining. This lining catches a lot of dust and dirt in the air you breathe.



2. The voice box (larynx) is at the upper end of the trachea. The student may know it as the Adam's apple. The larynx of the male enlarges as the body matures and this accounts for his deep voice.

3. The dangers inherent in using spray cans should be pointed out here. Many products are packaged this way, so people must make an effort to avoid breathing in the vapors of deodorants, hair sprays, insecticides, and so-called "air fresheners."

Exploration 2. Parts of the Breathing System

Overview

The major objective in this Exploration is to help students understand the mechanics of breathing. For enrichment, you may want to have pupils bring in magazine and newspaper articles on air pollution, emphysema, and lung cancer.

Behavioral Objectives

After completing this Exploration, the students will be able to

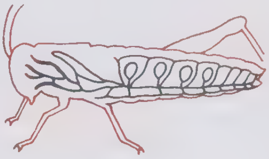
(1) identify the parts of the breathing system.

(2) trace the path of air between the nostrils and the air sacs.

← H 183

Exploration
2. Parts of the Breathing System

AIR, AIR, EVERYWHERE. Animals and plants all use it, but with different organs. The pictures show a variety of animal breathing systems. Today you will learn as much as possible about the parts of your own breathing system.



1. Part One Lungs and Tubes

Your teacher will cut apart the lungs of a cow or some other animal. Its lungs are a lot like yours.

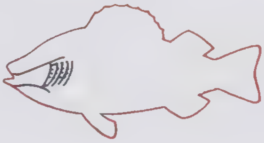
Touch the lung. How does it feel? Students describe.

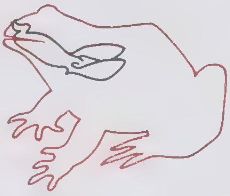
Do you think it is made of muscles? No.

Find the windpipe and the tubes that carry air into the lungs. What do they look like? White, flexible, with ridges.

Why do these tubes have to be open all the time? To allow free passage of air.

Cut a small piece of lung and place it in a jar of water. What happens to it? Why do you think this happens? It floats because of the air in the air sacs.





How do these breathing systems compare to yours?

Materials for Teacher

lung-heart-trachea combination
dissecting tools
sharp knife
dissecting pan
glass tubing

Time

Two days

1. **Part One** You can obtain a fresh lung with heart and trachea from a slaughterhouse. If not you will need to buy one from a butcher.

Try to put a small glass tube into one of the air tubes and blow into it. What happens? Section of lung may inflate.

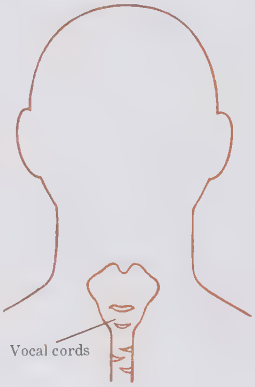
2. **Part Two An Important Pipe**

Rub your hand over the upper part of your throat and feel your windpipe.

What does it feel like? Round tube with ridges. It is flexible.

Why do you think the windpipe has to be both hard and flexible? So it will allow passage of air and movement of neck.

→ H 184



Hold your hand over your voice box. Say your name and address out loud. Try talking in a deep voice and a squeaky one. Can you feel the vibrations of the vocal cords? Yes.

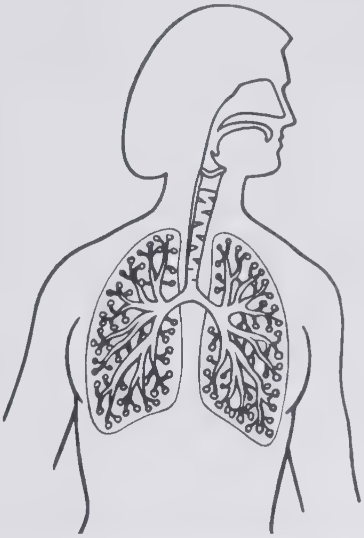
When you want to say something, you force air past the vocal cords. That makes them vibrate. It's something like plucking the strings on a guitar. These vibrations make the sound waves you hear when you talk.

Some deaf people can understand speech by touching the speaker's throat over the voice box. How do you think they can understand what the person is saying? The vibrations for different words will feel different to them.

2. **Part Two** A human torso and wall charts will help the students learn the parts and show how they are oriented in the body.
3. **Part Three** You may need to work more directly with students on this activity.

3. Part Three Airways

Study the diagram. Use a pencil and show by arrows the path that air takes from the nostrils to an air sac.



List in order the parts that the air passes through on this journey.

Nostril, back of mouth, windpipe, large tubes, smaller tubes, air sac.

Now list in order the parts that air passes through on the reverse trip, from the air sac to the nostrils. **Air sac, smaller tubes, large tubes, windpipe, back of mouth, nostrils.**

Hard cover users: To reproduce the diagram for Part Three for this Exploration please turn to page T 62 or direct students to the Laboratory Supplement.

→ H 185

How is the air that goes out of the lungs different from the air that went in? Air that goes in has more oxygen than air that goes out.

Check Yourself

1. Why can't you breathe and swallow at the same time? A flap closes the windpipe when you swallow.

2. What is the breathing problem that both astronauts and underwater explorers have? Their environments lack useable oxygen.

3. How do they solve this problem? They carry their own air supply.

4. Why do you need millions of air sacs? To supply surface for diffusion of oxygen and carbon dioxide.

Research You Can Do

Mexico City is over two kilometers above sea level. The air is thinner there. That means the molecules are more spread out. So there are less oxygen molecules in a lungful of air.

In 1968 the Olympic Games were held in Mexico City. Find out how the thin air affected the athletes. Do you think that Mexico City was a good place to hold the Olympics?

Exploration 3. How You Breathe

Overview

This Exploration is an extension of the last one. The concept of complementarity of structure and function can be strengthened as you explain the mechanics of breathing. The students review the method of figuring an average and compare the normal breathing rate after exercising. The increased breathing rate may remind the students of the increase in the pulse rate after exercising. Show that there is a connection between the two.

If you have time for Part Five, it will be fun. The students will make a contest out of it. You might like to try it, too.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) explain the functions of the diaphragm.
(2) record breathing rates before and after exercising.

Materials for Each Group

model of lung (bell jar)
stopwatch
gallon jug like a cider jug
2-holed rubber stopper to fit jug opening
2 pieces of glass tubing (bent)
food coloring
small pieces of rubber tubing (7½ cm)

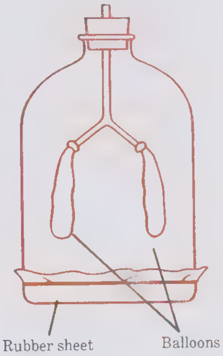
Exploration

3. How You Breathe

IN THE LAST LESSON you saw what lungs look like. The exploration today will help you understand how air is forced in and out of them.

1. Part One A Model of You

The picture shows the model you will use. Work with it for a few minutes by changing the position of the rubber sheet. Notice what happens to the balloons.



What part of your body do the balloons stand for? Lungs.

Since the lungs are not muscles, they can't move by themselves. Air has to be forced in and out of them. A strong muscle called the **diaphragm** (*DY uh fram*) does the work. It is a moveable wall below the heart and lungs. The diaphragm moves up and down like the rubber sheet in your model.

What happens to the balloons when the rubber sheet is pulled down? They fill with air.

What happens to the balloons when the rubber sheeting is pushed back up? They collapse.

Why do the balloons change as you move the rubber sheet up and down? When the sheet is down, the air pressure around balloons is lessened and air rushes in. When the sheet is up, air pressure around balloons increases, forcing air out.

← H 186

Time

Two days

1. **Parts One and Two** Guide students to the understanding that the diaphragm and ribs help you inhale and exhale.

Part Two Now You Do It!

Take a deep breath and fill your lungs with air.

Do you think your diaphragm went up or down as you inhaled (breathed in)? Down.

What else moved (besides your diaphragm) as you inhaled? Your chest (rib cage).

What happens to your diaphragm as you exhale (breathe out)?

It moves up.

2. Part Three How Fast Do You Breathe?

Have someone be the timekeeper as you count the number of times you inhale in one minute.

How many times did you inhale in one minute? Varies.

How would you find the average breathing rate for your class?

Add all breathing rates and divide by number of students.

3. Part Four Help Wanted: More Oxygen!

Jump up and down 20 times and check your breathing rate for one minute.

How many times did you inhale in one minute? Varies.

What is the difference between your breathing rates after exercising and before? Exercise increases breathing rate.

2. Part Three You may need to help students compute averages.

3. Part Four Help students discover that there is a connection between breathing rate and pulse rate.

4. Part Five The class usually enjoys this lab. At first they may be shy but after getting over that phase, they usually make a game of who has the greatest lung capacity. Don't become alarmed by spilled water. A mop will placate all, including maintenance men.

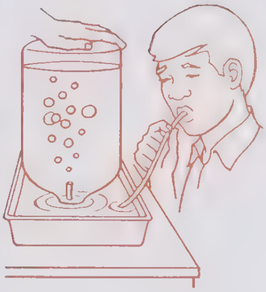
Why do you think there is a difference? Exercise creates a need for more oxygen.

4. **Part Five How Much Air Do Your Lungs Hold?**

Do this part if you have time. Set up a gallon bottle filled with water in a large pan. The neck of the bottle should be below the water level in the pan. Inhale and exhale deeply three times. Then take a deep breath. Blow it out into the tubing.

Mark your initials with a grease pencil at the new water level. If you cover the mouth of the bottle, you can turn it right side up. Then you can measure how much water flowed out. That equals the air you blew in.

Have several members of the class try this. Be sure to clean the end of the tubing before other students put their mouths on it.



← H 187

How much air did you exhale from your lungs? Varies.

This amount of air is called your **lung capacity.** Your lungs hold more than that, but you can never really empty them. What is the lung capacity for each person that did this test? Varies.

How would you find the average lung capacity for the class? Add up all lung capacities and divide by number of students.

When fireman William Carroll pulled the child from her smoke-filled room, she was not breathing. He saved her life by mouth-to-mouth breathing.

How would you find out how the lung capacity of athletes compares with the class average? By testing a group of athletes and getting their average.

How could you find out whether smoking affects the capacity of the lungs? By comparing the average of a group of smokers with the average for the same number of nonsmokers.

Would testing one athlete and one smoker give you enough information to answer the last two questions? Why do you think so?

No. They may not be representative. Best to test a group.

Check Yourself

1. What gas do you take in when you inhale? Oxygen.
2. What gas do you give off when you exhale? Carbon dioxide.
3. Why do you need oxygen? To combine with food to supply energy.
4. Where do you need oxygen? In all cells.
5. How does oxygen get out to your fingers and your toes? It is carried by the red blood cells.

Reading
4. Putting the Oxygen to Work

Breathing oxygen after a hard run helps him to catch his breath.

1. MANY PARTS work together in your body. And much of this work is done just to get food to your trillions of cells. Try this — it might surprise you! List in the margin all the parts of your body that worked to get your cells their last meal.

The energy that makes you go is locked up in food. It takes oxygen to help release this energy. That's why you need a breathing system.

Reading 4. Putting the Oxygen to Work

1. You might want to remind the students that food is the fuel that supplies them with energy, just as gasoline is fuel that supplies a car with energy.

2. The nutrient that is directly used for energy is glucose. You remember that glucose is called the body sugar. It is the sugar that is carried in the blood to all the body cells. With the help of oxygen, glucose is broken down in the cells. As this happens, you get a supply of energy.

H 189

You need energy all the time. You need it just to stay alive — to breathe, to digest food, to keep your heart beating. At times you need a lot of energy — to dance, to play football, or to sweep a floor. At times you need only a little energy — to study or to sleep.

You can get about 23 calories of energy from a tablespoon of glucose.

After the glucose is broken down, the energy must be stored. It must be stored in such a way that you can use just a little or you can use a lot. It must be stored so you can use it without waiting. 3-4. There are special molecules in the cells that store energy. When you need a little energy, you use up some of these special molecules. When you need a lot of energy, you use up many more of them. Storing energy in molecules is like packing something you need in many small boxes instead of one big one. Then you can unpack the right amount each time without opening more than you need.

H 190

How long could you do the actions in these pictures by using the energy in a tablespoon of glucose? Walking takes about 3 calories per minute. Bike racing takes 10. Reading takes 1.5. Swimming takes about 11. Peeling potatoes takes 2. And sweeping takes 5.

2. The energy is released from food in the cell.
3. The molecule that is used to store energy is ATP. If the class can handle it, you may want to make this point.
4. The powerhouse of the cell was mentioned in a previous lesson. This is where most of cellular respiration takes place.

5. You are probably sitting right now. If you are, you are using a small amount of energy. But your cells have enough energy stored in the special molecules to let you suddenly be active. You can jump up and run out without first stopping to eat.

After each glucose molecule is completely broken down, molecules of water and carbon dioxide are left over. The water can be used by the cell. But the carbon dioxide is waste for us. It is sent out of the body.

Exhaling on a cold morning. What causes the clouds you see?

5. How much you elaborate on this Reading depends on your class. The complex chemistry is not needed, however.

← H 192

Exploration
5. Air Pollution

More people, more cars, more trucks, more factories, more houses to heat, more airplanes, more garbage to burn. More dirt in the air! In this lesson, you will do some experiments to see how dirty the air is.

Exploration 5. Air Pollution

Overview

Air pollution is a matter of great concern to all of us because it is a health hazard to the respiratory system. The class has read about pollution and, in a previous lesson, has learned that air pollution may cause lung diseases. If your school is in a big city, the students have seen smoke from the stacks of factories and incinerators. They may know that cars and planes add to the problem.

In this Exploration the students will collect particulate matter, observe it under the microscope, count particles, and compare the dustfall in different locations. This activity will reinforce their background in computing averages and planning experiments.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) design experiments to observe dust particles in the air and record their findings.

(2) compare the number of dust particles in different places and make a bar graph of the results.

(3) identify one or more sources of air pollution.

Materials for Each Group

wax pencils
microscope slides
petroleum jelly
microscopes

→ H 193

The sticky lining of your large air tubes can catch a lot of dirt in the air. But smoke and smog damage the lining of the air tubes. Then more air pollution gets past the lining and down into the lungs.

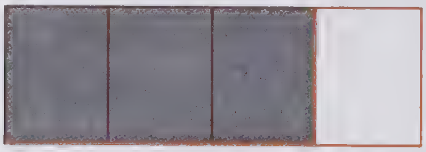
Two of the worst diseases of the lungs are **bronchitis** (*brahng KY tihs*) and ***emphysema*** (*ehm fuh SEE muh*). In these diseases the small air tubes are affected. It becomes hard for air to get in and out of the air sacs. Also, the air sacs can't do a good job of exchanging oxygen and carbon dioxide.

Sometimes the growth of the cells in the lungs is also affected by pollution. This can cause the disease called lung cancer.

Dirty air is one cause of bronchitis, emphysema, and cancer. People in big cities get these diseases more often than people living in the country. Air that is full of cigarette smoke is very dirty. So cigarette smokers get these diseases more than nonsmokers. If you live in a big city *and* smoke, your breathing system will have double trouble.

1. Part One Sampling the Dustfall

2. Use a wax pencil to divide a microscope slide into four sections. Turn it over and cover the first three sections with a very thin layer of petroleum jelly (vaseline). Leave one section clean so you can pick up the slide. Can you guess why you made the slide sticky?



3. Place your slide on an outside window sill. Be sure the sticky side is up. Let it stay overnight.

The next day, look at the slide. How does it look? **Student's description.**

Time

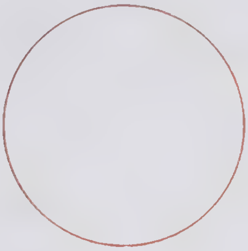
Three days

1. Parts One and Two If this Exploration is started on a Friday, much more particulate matter will be picked up over the weekend. Remind the students that they have already used the sampling technique for getting data when they sampled a population. If they didn't do any sampling, take a few minutes to remind them what is meant by a sample.

2. Be sure that all the students smear the petroleum jelly on ¾ of the slide and leave ¼ clean for ease of handling.

3. A clip clothespin on the clean end of the slide will give you a handle or possibly a way of hanging the slide on a hook or a line. This could give you a chance to test the effect of wind direction by facing a slide into the wind and one in the opposite direction.

Use the low power objective of your microscope to look at one section of the slide. Draw the particles you see.



Are all the particles the same size? Varies.

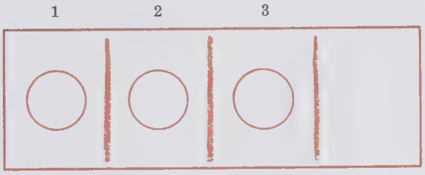
Are all the particles the same color? Varies.

Are all the particles the same shape? Varies.

Focus on the center of the first section of the slide. Count the number of particles that you see. Write the number on the diagram below.

Focus on the center of the second section of the slide. Count the number of particles that you see. Write the number on the diagram below.

Focus on the center of the third section of the slide. Count the number of particles that you see. Write the number on the diagram.



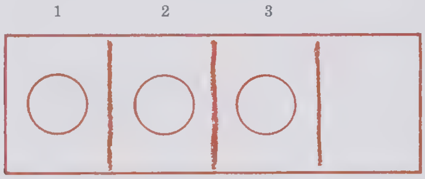
Take an average of these three counts. Varies.

4. Part Two Comparing the Dustfall

Plan an experiment to compare the dirt in the air in different places. You might want to compare the air in school with the air at home. Or compare the air inside a building and outside. Or compare the air near a factory and near a park. Or you may have another idea. Use sticky slides to test your idea.

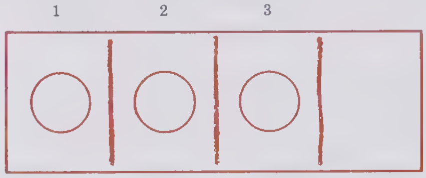
Write your plan here. Student's plan.

After you get your results, fill in a diagram for each place you sampled. Write the number of particles you counted in the center of each section of your slides.



The place you sampled Varies.

Average number of particles Varies.



The place you sampled Varies.

Average number of particles Varies.

4. Some air pollution has been caused by the unusual number of volcanoes that have erupted in the last few years. It takes several years for the dust from such a natural event to settle. The testing of atomic weapons is a threat to air quality.

Reminder: Order or obtain pig or lamb kidneys for Chapter 9.

← H 195

Figure out the average number of particles for each slide.

Share your results with the rest of the class. One way to do this is to write all the results on the board. List the highest average number first and end with the lowest number.

What is the advantage of listing the information in order? It is easier to see the range and to make comparisons.

If you have time, make a bar graph to show the same information.

← H 196

Check Yourself

1. How did the particles get into the air? From factories, homes, cars, soil, plants.

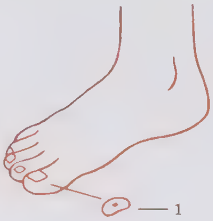
2. Which place that you tested had the dirtiest air? Can you explain why? Varies.

3. How might this dirty air affect your breathing system? It gets into lungs and may cause asthma, allergic reactions, or general discomfort.

4. What can be done to reduce air pollution? Let students speculate.

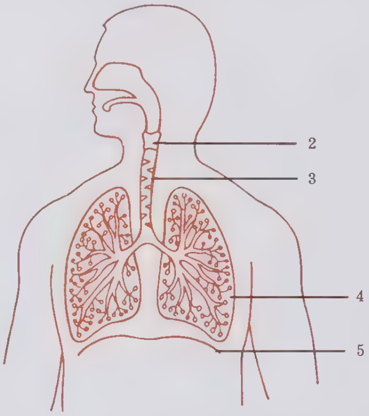
Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 41 or direct students to the Laboratory Supplement.

Use Your Wits!



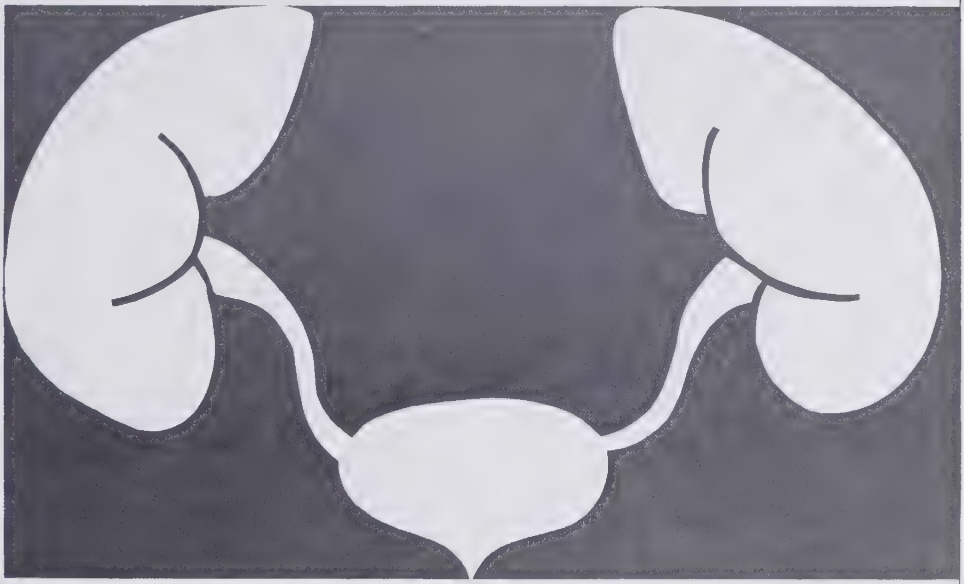
HERE IS A CELL in your big toe that needs oxygen. It must also get rid of carbon dioxide, which is waste.

Here are the parts of the body that take oxygen into the body. They also send the carbon dioxide out of the body. Match the numbers from the diagrams with each item below. You can use a number more than once.



5 a. the muscle that forces air in and out of the lungs
4 b. the lungs
3 c. the windpipe
4 d. where the blood picks up oxygen
1 e. where the blood picks up carbon dioxide
5 f. the diaphragm
4 g. where most of the capillaries that take in oxygen are
2 h. where the voice box is
4 i. where the air sacs are
1 j. where the oxygen is used.

9 Controlling the Internal Environment



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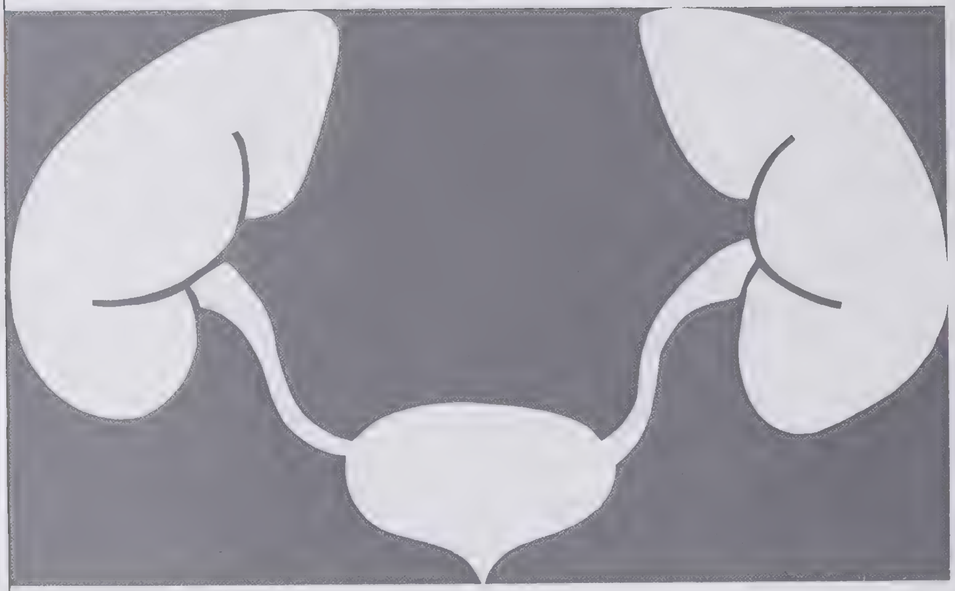


Reading
1. Cells Need a Healthy Place to Live

1. THE BODY CELLS are surrounded by a salty fluid. Everything the cells need to stay alive passes through this fluid from the bloodstream. And everything the cells have to get rid of passes through this fluid into the bloodstream.

2. The body fluid is the environment for the cells. One job of the **excretory** (*EHK skruh tawr ee*) system is to keep the cells and their environment clean.

3. If wastes aren't removed from the blood, they pile up and poison the body. Even salt and sugar can harm your body if they pile up. Also, if there is too much water in the body, it must be removed. If there is too little water, it must be saved.

Different parts of the body help to get rid of wastes. When you sweat, you lose water, **urea** (*yoo REE uh*), and salts through your

Reading 1. Cells Need a Healthy Place to Live

1. Up to this point we have been talking about delivering materials to the cells. Now we are concerned with carrying materials away from the cells.

2. Remind the students about the importance of the internal environment. The internal environment must be controlled in order to maintain conditions for good health.

3. The role of the kidneys has been compared to that of a master chemist that is on the job 24 hours a day. They control the chemistry of the blood.

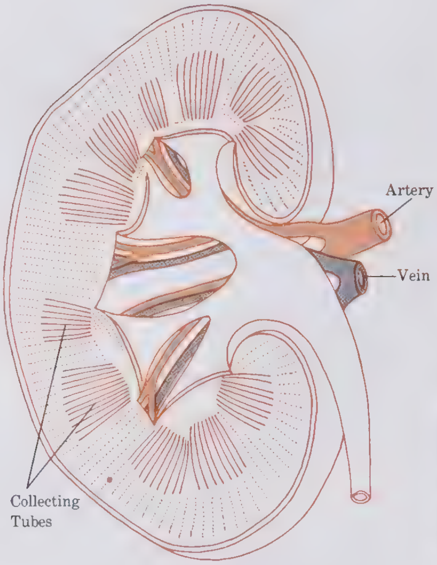
skin. Urea is a waste material that is also in urine. Your lungs remove the extra carbon dioxide from your blood. The food you don't digest is turned into solid waste in the large intestine and is then removed from the body.

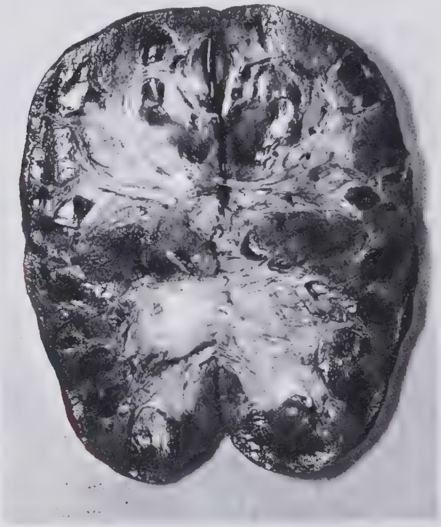
The skin, the lungs, and the large intestine all have a part in getting rid of body wastes. But the largest role is played by the **kidneys.**

4. Each kidney has over a million tiny tubes. A large artery brings blood to the kidney, and branches into many capillaries. The main work of the kidney is done where the tubes and the capillaries come close together. Here the wastes are removed from the blood.

5. The waste that collects in the tubes of the kidneys is called **urine.** The urine collects in a large empty space inside the kidney. From there it passes through a special tube to the **bladder.** The bladder stores the urine until it leaves the body.

Urine is collected in small tubes in the kidneys. The small tubes connect to bigger and bigger tubes until they leave the kidney. What are the dark patches in this photo of a kidney cut in half?





4. Be sure to point out that the capillaries and tubes do *not* run into each other but come close to each other. Remind the students about diffusion.

5. The solid wastes that are handled by the large intestine have played no part in metabolism but are made up of undigested material. It is the liquid wastes that are the result of cell metabolism.

Exploration 2. The Living Filters

Overview

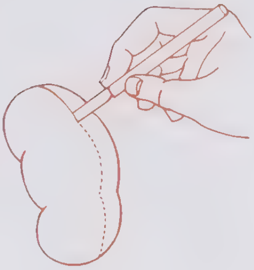
The Reading "Cells Need a Healthy Place to Live" should be assigned before this Exploration is attempted. If the Reading has been done, the class should know that the kidneys are important in maintaining the chemical balance in the body.

The dissection of a kidney is simple as the students will be looking for gross structure. This is a good place to show how the circulatory system coordinates with the excretory system.

Exploration
2. The Living Filters

Today you will study a kidney from a pig or a lamb.

1. Part One A Kidney a Lot Like Yours



Look at the outside of the kidney. What is its shape? Students describe what they see.

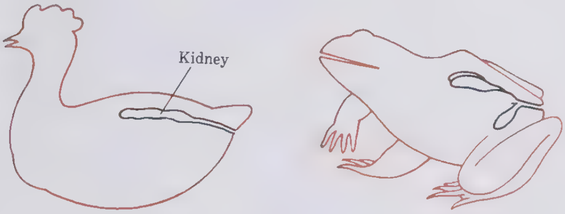
Try to find the places where a tube or a blood vessel was joined to the kidney.

Working carefully, cut the kidney in half the long way. Look at the inside of the kidney. Try to find the place where urine collects before it leaves the kidney. What does it look like? Student's observation.

Find the tube that carries the urine out of the kidney. This tube is called the **ureter** (*yoo REE tuhr*). Where does the ureter lead in a living animal? Bladder (urinary).

Two large blood vessels are connected to each kidney. One is a vein. The other is an artery. Sometimes after the butcher trims the meat, the blood vessels are hard to find.

Birds don't have bladders; frogs do.



Behavioral Objective

After completing this Exploration, the students will be able to

(1) describe the function of the kidney and name the parts of the body urine passes through as it is excreted.

Materials for Each Group

pig or lamb kidneys
dissecting tools
sharp knives
charts and models (optional)

Time

Two days

1. Part One Pig or lamb kidneys are preferred because the structure is more like a human's.

→ H 202

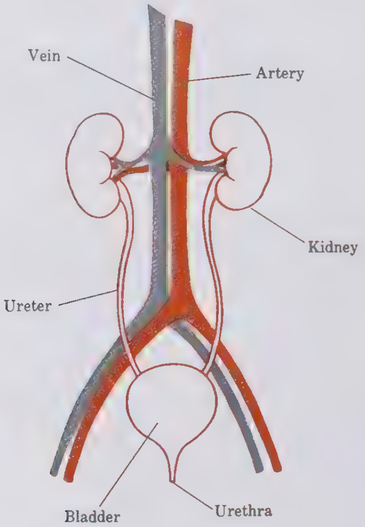
Hard cover users: To reproduce the illustration of the kidneys for this Exploration please turn to page T 63 or direct students to the Laboratory Supplement.

Can you find the blood vessels on your kidney? Varies.

What work does each blood vessel do? Arteries bring blood from body cells to kidneys. Veins return blood minus waste products to circulatory system.

2. Part Two Human Kidneys

Draw arrows on the diagram to show the path of blood from the large artery through the kidney to the large vein that carries blood back to the heart.



Name the parts of the body that urine passes through as it goes from the kidneys to the outside of the body. Kidney, ureter, urinary bladder, tube leading out of the body (urethra).

2. Part Two Review this activity using a chart. Have the students point to parts of the excretory system.

Research If enough material on the kidney machine is brought to the class, a debate can be arranged. The debate is a technique that the students may know little about. You might explain this is one way to examine all sides of a question. Debate suggestion: Resolved, that the government should make kidney machines available to everyone who needs one.

Reminder: Order frogs for Chapter 11.

Check Yourself

1. How many kidneys do you have? Two.

2. How is the blood that leaves the kidneys different from the blood that goes into them? Materials that are wastes to the body have been removed.

3. Where does the waste in urine come from? The body cells.

4. What parts of the body help the kidneys to get rid of wastes? Skin, lungs. Heart pumps blood to kidneys and through body.

5. What is the bladder's job in getting rid of waste? It stores the urine until it is removed from the body.

A kidney machine can clean the wastes from a person's blood. Many people are kept alive by getting hooked up to a kidney machine every few days.

← H 203

Research You Can Do

You may have heard of kidneys being taken from one person and put into another person. Find out all you can about this operation. It is called a kidney transplant operation.

Kidney machines are used to help people whose kidneys have stopped working or are working poorly. Find out all you can about these machines. Try to find out why so many people with kidney diseases are not hooked up to kidney machines and finally die.

You can get some up-to-date information on kidney research in *New Parts for People* by Nancy Rosenberg and Reuven K. Snyderman, M.D.

← H 204

1. Skin is in the middle. It is in between the environment inside you and the environment outside you. It has to adjust to both places. And it does.

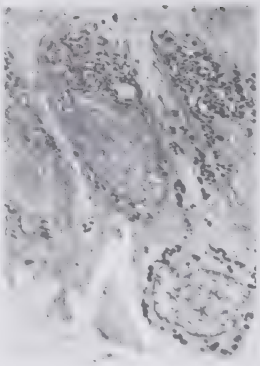
The skin adjusts to changes in your size and shape. It's elastic. Whether you gain weight or lose it, your skin still fits you. When you move, it stretches or shrinks. It's a suit that always looks just the right size.

Reading 3. The Organ in Between

1. Here is a chance to review what the class knows about other animals and how their body covering helps them maintain a steady state. The insects, earthworm, frog, and bird have been studied. The fish and the mammals are familiar. Even plants must have a covering that is waterproof and protective.

Skin also has to adjust to a world that rubs, scrapes, and cuts you. When it's cut, the skin repairs itself. A special part of the skin called the **epidermis** (EHP *uh DUR mihs*) solves the rubbing problem. The epidermis is what you see, the outside of your skin. On the top there is a layer of dead cells. These dead cells are constantly rubbed off by things you touch. But they are replaced from the layer of live cells underneath. So your skin is always changing.

The epidermis also keeps you waterproof and helps keep disease germs out of your body.



Melanin grains

Skin color is another adjustment to the outside world. Too much sunlight can give you a sunburn or even skin cancer. Grains of color in your epidermis absorb some of the sun's rays. The grains are made of **melanin** (*MEHL uh nihn*). Melanin is dark brown. Almost everyone's skin has some melanin in it. People with a lot have dark skins. People with a little melanin have light skins.

If a person's skin cells can't make melanin, he or she will be light pink, almost white. Such people are rare. They are called **albinos** (*al BY nohs*).

The **dermis** (*DUR mihs*) is a thick layer in the skin under the epidermis. The dermis is a busy place. This is where the blood vessels, nerves, sweat glands, oil glands, and hair roots are.

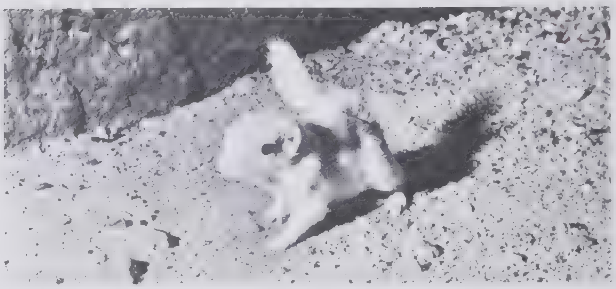
Sweating helps keep your body at an even temperature. Doing work makes a lot of waste heat in the body. The blood carries this heat off to the skin. On cold days the skin can get rid of most of the heat by giving it off to the air. On warm days you sweat more.

Sweat is made up of a little urea, some salt, and a lot of water. When you sweat, you are giving off water and waste material.

Sweating is normal and necessary. It goes on all the time. You sweat a little — without noticing it — even when you aren't hot. When you are hot, the skin quickly adjusts — you sweat a lot more.

As the water in sweat dries up, it cools your skin. Try this activity and you will see why. First blow gently on the back of your hand. Now wet your hand and blow on it. Is it cooler now?

Squirrels and other animals sometimes come in albino forms.



Exploration 4. The Skin

Overview

In this pencil laboratory lesson, the students will have the opportunity to study the structure of the skin. Remind them of the importance of the skin as an excretory organ and as an organ of temperature control. Discuss the importance of keeping the skin clean.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) identify the parts of the skin on a diagram.
(2) describe some functions of the skin.

Materials for Each Group

pencils

Time

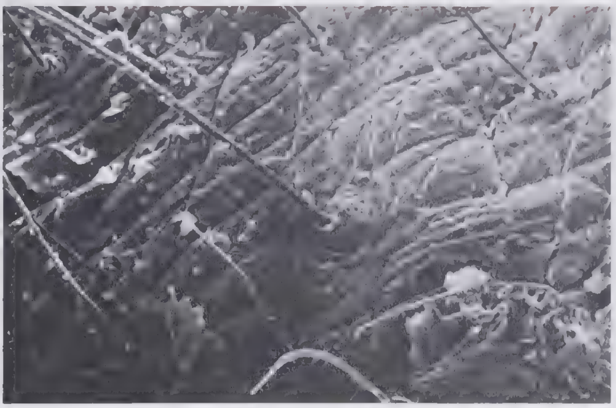
Two days

Parts One and Two Stress the fact that the wastes that are in sweat are similar to the wastes that are in urine and originate in the body cells.

1. Models and charts of the skin should be brought into the class. Pamphlets on skin care are available from the Metropolitan Insurance Company.

2. Students should know by now that they sweat all the time. More water is in the sweat when it is needed to cool the body.

Exploration
4. The Skin



Old skin cells peel off human skin and are replaced by the cells below. × 100

Today you will take a closer look at your skin. You will learn how it is built to help it work for you.

Part One The Surface

1. The epidermis does not look the same all over. Describe the epidermis at these places on your body:

The epidermis that helps the fingertips grip an object Student describes (tough-rough).

The epidermis that allows the knees and knuckles to bend Student describes.

The epidermis that lets you see through the pupil of your eye Student describes (thin, transparent).

3. Point out the presence of nerves in the dermis. Nerve fibers are especially dense in the skin of the face, palms of the hands, and soles of the feet.

The epidermis that protects the bottom of your feet Student describes.

Part Two The Inside

2-4. Look at this diagram of a tiny piece of skin. Notice the thickness. Use a blue pencil to color the sweat glands and the tubes leading to the openings in the skin.

What are the openings in the skin called? Pores.

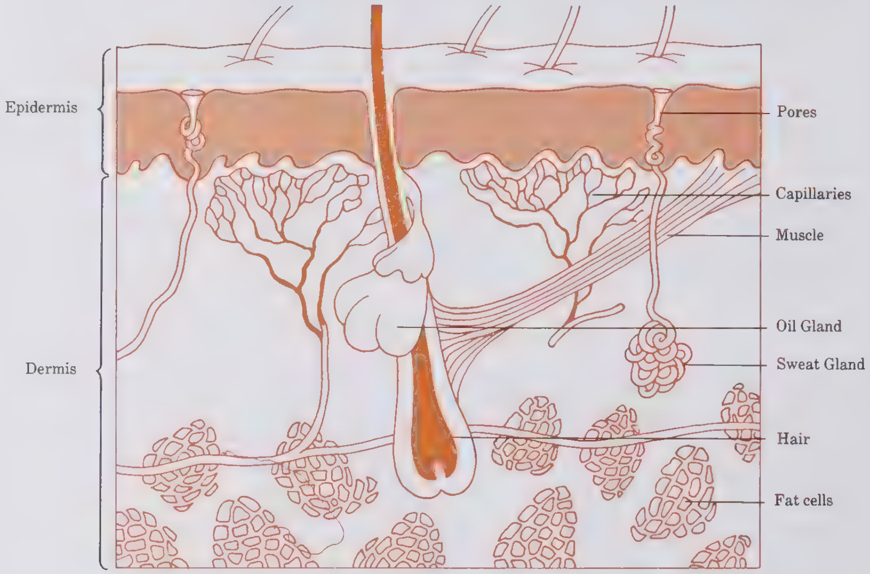
How many sweat glands are in the picture? One.

Use a red pencil to color the blood vessels near the sweat glands.

→ H 207

Why are the blood vessels so close to the sweat glands? Waste materials and water can diffuse out of the blood and into the sweat glands.

Hard cover users: To reproduce the diagram of the skin for this Exploration please turn to page T 63 or direct students to the Laboratory Supplement.



4. The hypothalamus is the part of the brain that regulates the body temperature by causing the responses that we see in the skin.

5. Fat is an emergency food supply as well as an insulating material. The female body has a greater abundance of fat and therefore is not as sensitive to cold.

6. This activity may be used to involve the students in a discussion of skin problems that are of prime importance to them. This can be of great value if handled correctly. Try to let the students do most of the talking; avoid dominating the discussion. Acne, skin color, and sweating often are of concern to teenagers. (Much of TV advertising is in this area.) Give them the opportunity to air their ideas. Perhaps you will be able to correct some misinformation they may have on the subject of skin in general. As an example some students may have found that some antiperspirants irritate their skins. Therefore students should use a small amount until they are certain that no irritation will result.

Sweat is made mainly from water, salt, and a little urea. Where do these materials come from? Body cells.

5. Find the fat cells in the skin. Fat is a good insulator. This means it will help keep body heat in when the outside environment is cool.

In what part of the skin do you see most of the fat cells? Dermis.

How many hairs are in the diagram? Five.

Why would it hurt to pull out a hair? Pulling from a living area supplied by nerves.

Does it hurt to cut a hair? No. What does this tell you about hair? No nerves in the hair itself.

Use one of your pencils to color the muscle attached to a hair.

What happens to the hair when the muscle is shortened? Hair stands up.

Can you think of a time when a lot of your hair muscles became shortened? Student speculates.

Look for an oil gland. It keeps your skin smooth and soft. Where is its opening? Adjacent to hair follicle.

← H 208

6. If the tube of an oil gland or a sweat gland becomes infected, a pimple may start to form. Put an X on the diagram to show such a place.

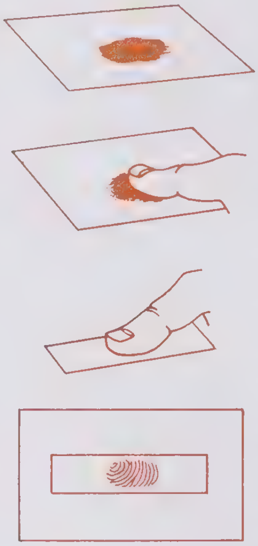
Check Yourself

1. How do the sweat glands help the kidneys? They excrete water, urea, and salts.

2. How is the skin of young people and old people different? Young person's skin is firm, smooth, and unwrinkled; older person's skin is thin, dry, and wrinkled.

3. If you are cold, less blood flows to the skin. How do you think this would help you keep warm? Skin helps cool the body. Less blood to the skin keeps heat in body.

4. How is the skin a protection to the body? Keeps out bacteria. If cut, burned, or destroyed it can repair itself (within limits). Skin is waterproof. Melanin in skin helps protect from too much sun.



Research You Can Do

When a person has a lot of pimples, he or she has acne. Try to find out what causes acne and what can be done to control acne.

Fingerprints are caused by ridges in the epidermis of the hands. They are a personal signature. No two people have the same fingerprints, not even identical twins. These patterns form five months before a person is born, and they never change. Find out how fingerprints are important in detective work.

Here is an easy way to take your own fingerprints. First, use a soft pencil to make a black patch on a piece of paper. Then rub a finger over the black patch. Now, carefully press your finger on a clean piece of paper. It should leave a fingerprint. Cover the fingerprint with a piece of Scotch tape. Compare your fingerprint with your friends' fingerprints.

Exploration 5. Keeping Cool

Overview

Thinking critically and drawing conclusions are important goals in this Exploration. Remind the class that they are using the metric system when they use the Celsius thermometer.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) use both Fahrenheit and Celsius thermometers.
(2) compare Celsius and Fahrenheit scales.

Materials for Each Group

Fahrenheit and Celsius thermometers
cotton
water
paper towels

Time

Two days

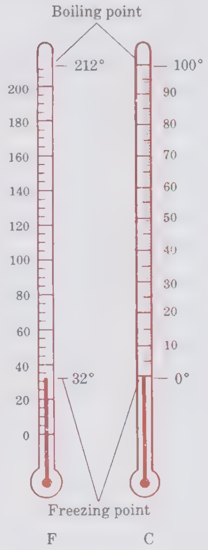
1. Part One Remind students not to hold the thermometer by the bulb.

Exploration
5. Keeping Cool

IN THIS LESSON you will learn about thermometers. Then you will use them to see how sweating keeps you cool.

Part One Two Thermometer Scales

The **Fahrenheit** (*FA ruhn* HYT) thermometer is the one used most often in the United States to measure body temperature and air temperature. The **Celsius** (*SEHL see uhs*) thermometer is used in most scientific work.



Look at the thermometers and fill in these numbers:

The freezing point of water on the Celsius thermometer 0°C

The freezing point of water on the Fahrenheit thermometer 32°F

The boiling point of water on the Celsius thermometer 100°C

The boiling point of water on the Fahrenheit thermometer 212°F

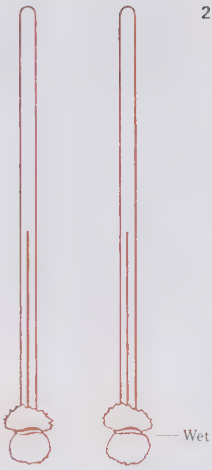
The average human body temperature is 98.6°F (degrees on the Fahrenheit thermometer). What is human body temperature on the Celsius thermometer? 37°C (approx.) °C

When room temperature is 70°F, it is 21°C (approx.) °C.

Get a thermometer from your teacher. There is a liquid inside the long thin tube. This liquid expands when it is heated. That makes it move up inside the tube. When the liquid is cooled, it shrinks and goes down the tube.

Find the mark where the top of the liquid is now. This is the room temperature. What is it? Varies.

Are you using a Celsius or Fahrenheit thermometer? Varies.



2. Part Two What Good Is Sweating?

Use two thermometers of the same kind. Tie a small piece of cotton around the bulb end of each one. Wet the cotton of one thermometer with water at room temperature. Keep the other cotton dry. Carefully lay both thermometers on your desk top.

What is the temperature of the dry bulb thermometer? Varies.

What is the temperature of the wet bulb thermometer? Varies.

Use a piece of paper or cardboard for a fan. Fan both thermometers for ten minutes. The water on the wet cotton will start to evaporate (dry up).

What is the temperature of the dry bulb thermometer now? Varies.

What is the temperature of the wet bulb thermometer now? Varies.

What is the difference between the temperatures? Student determines answer.

What effect did the evaporation of water have on the wet cotton?

Cooling.

How does sweating affect the temperature of your skin?

Cools it.

Check Yourself

1. How are the sweat glands in the skin important to the body?

Cool body. Rid body of waste products.

2. If you didn't know whether a thermometer was Celsius or Fahrenheit, how could you find out? Either place thermometers in boiling water or freezing water (ice slush). Check reading. If 100° in boiling water, thermometer is Celsius. If 212° it is Fahrenheit.

2. Part Two The more able students can help the others read the thermometers.

Research You Can Do

The lungs are organs that help get rid of body wastes. You may remember that they give off carbon dioxide. Carbon dioxide will turn limewater a milky white color. Try this. Blow gently through a straw into a test tube of limewater. Watch for the change.

The lungs also give off water. Can you think of a way to show that there is water in the breath that you exhale? Exhale on glass plate or mirror. Water droplets form.

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 42 or direct students to the Laboratory Supplement.

Use Your Wits!

THIS GAME is played like *Jeopardy* on TV. The answer box gives you the answers. You have to think of the questions.

ANSWER BOX

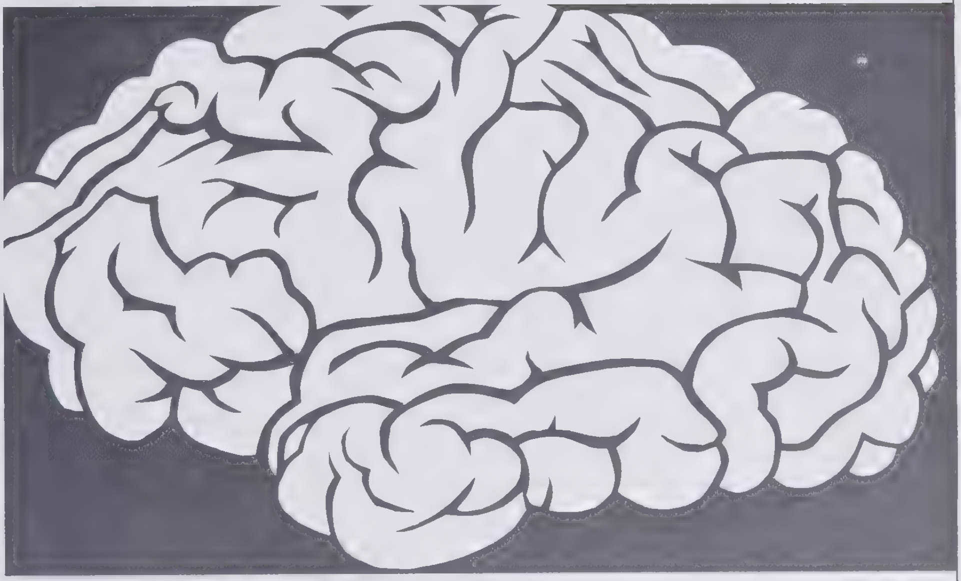
Points	Kidney	Skin	General
10	*two*	*dead cells*	*98.6°F*
20	*urine*	*acne*	*carbon dioxide*
30	*body cells*	*pigment*	*fingerprints*
40	*artery*	*sweat*	*evaporation*
50	*ureter*	*albino*	*Celsius thermometer*

Write as many questions as you can in the Question Box. Then add up the number of points you have earned.

QUESTION BOX

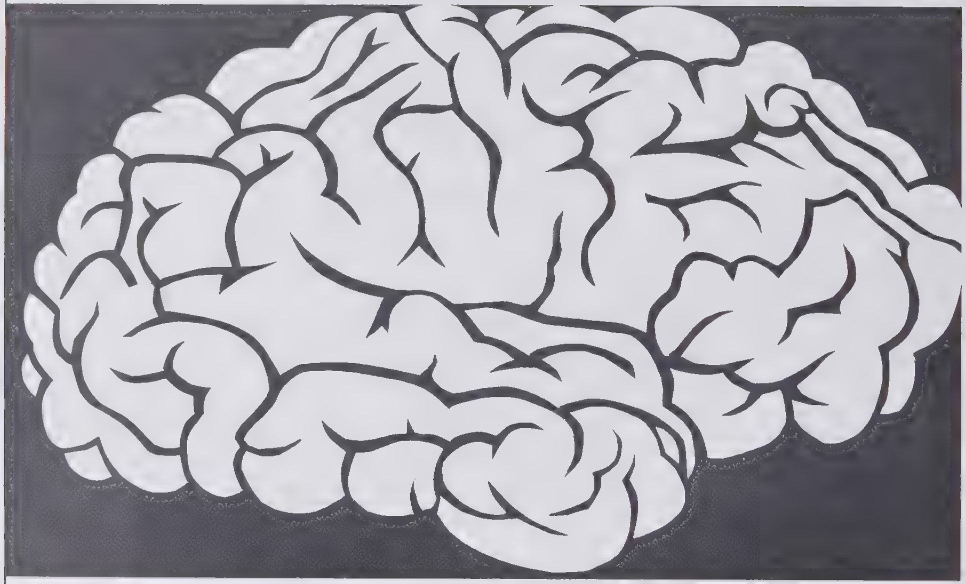
Points	Group	Answer	Question that matches the answer
20	*General*	*Carbon dioxide*	*What is the waste that is taken out of the blood by the lungs?*
		Student questions will vary.	

10 The Nervous System

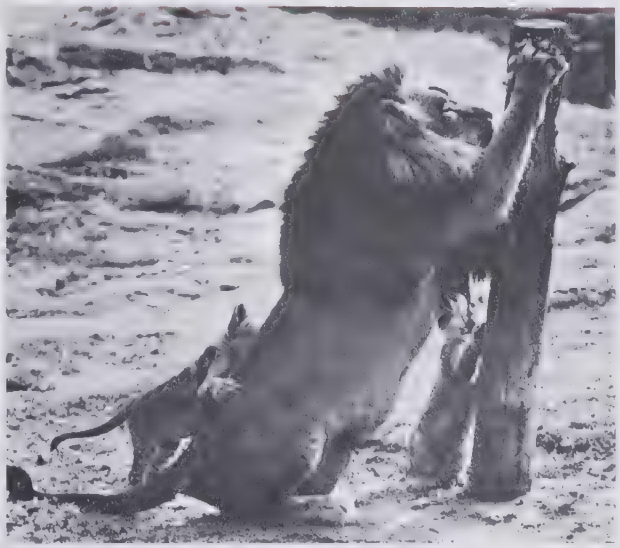


← H 211

H 212



Reading
1. The Brain



Baby lions learn to keep their claws sharp by scratching a tree trunk. One of them seems to have missed the point of the lesson.

MOST ANIMALS have many inborn responses that help them stay alive even when they are very young. People have to learn many of their responses. Human beings have long childhoods with lots of time to learn to use their brains.

Animals with long childhoods need adults around. The adults protect the children, feed them, and teach them. That is one reason why people and some other animals live in families.

1. During childhood, your brain learns to do some difficult things like talking and reading. It also learns how to make your muscles work together so you can walk, and dance, and use tools.

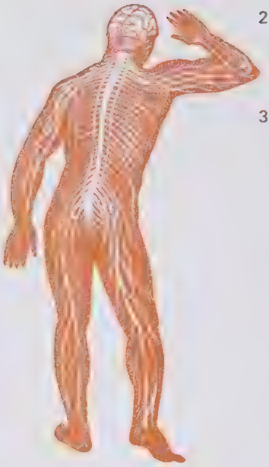
Your brain and spinal cord are the center of your nervous system. The spinal cord is made of big nerves coming down from the brain. They run through the backbone.

If your nerve cells are damaged, your body cannot replace them. So the brain and the spinal cord get a lot of protection. They are surrounded by a bony skull and backbone. They are also surrounded by a liquid to cushion them from shocks.

Reading 1. The Brain

1. The brain gets its information through the senses.

H 214



2. Long nerves and short nerves run into and out of the brain and spinal cord. Some are millimeters long. Some are a meter long. The nerves go to your eyes, ears, nose, mouth, skin, muscles, and internal organs. They go everywhere in your body.

3. The billions of nerve cells in your brain work together. They keep track of what goes on inside and outside your body. Messages from your body flash to your brain. Messages flash from your brain to different parts of your body. Messages flash between the cells of the brain. Thousands of messages every minute!

In many ways, your brain is like a busy telephone exchange. But instead of wires, nerves carry the brain's electrical messages.

A runner's brain might be sending and receiving these messages:

Muscles to brain: *We need more oxygen.*
Brain to heart: *Speed up!*
Brain to diaphragm: *Up, down, up, down! Faster! Faster!*
Ears to brain: *Footsteps close behind.*
Brain to legs: *Move, legs!*
Eyes to brain: *Hurdle ahead.*
Brain to legs, arm, and back: *Up we go!*

4. These are only a few of the thousands of messages the brain and spinal cord are sending and receiving. The runner hears the roar of the crowd. Her nervous system is directing the digestion of her breakfast. It is directing the sweat glands to help get rid of all the heat she's building up. She is also using her brain to think — to plan how to win the race. And her brain helps her feel the emotions you can read in her face.

5. The brain — what a fantastic organ!

2. You hear, see, taste, and smell with your brain. Eyes that are perfect cannot see unless their connection to the brain is intact.

3. Learning goes on all of one's life. It doesn't end with high school.

4. Besides depending on adults within a family to pass down information, in our society we are exposed to television, newspapers, radio, schools.

5. Ask students to speculate about how they would survive if they had been cut off from knowledge that had been gathered over the years.

Exploration 2. Brain Power

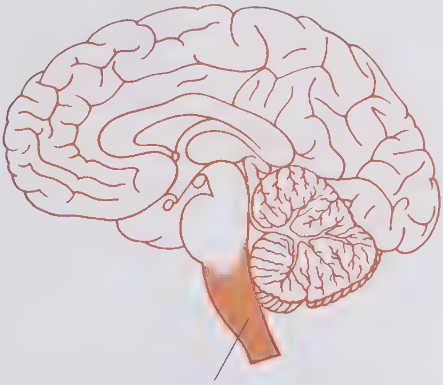
Overview

In this Exploration, the simple activities will lead the students to an understanding of the functions of the cerebrum, cerebellum, medulla, and hypothalamus. They will be directed to use diagrams in the book as a source of information and they will be asked to draw conclusions from data that they collect. If the class has covered the material on human behavior, there will be some background for this activity. The students know that the brain is capable of special kinds of thinking and of learning language and number symbols. They know that breathing and heartbeat are automatic and can be speeded up without conscious thought.

1. You are strolling down the street, chewing gum, and listening to a portable radio. You see houses and smell cooking smells. Maybe you are thinking about a person you know and a place you have to go. And you are breathing, pumping blood, digesting a meal. All at the same time. And it's easy! It's brain power!

Different parts of your brain take care of different kinds of brain work. In today's lesson, you are going to study four important parts. You will learn about the special work each part does.

2. Part One The Medulla



The inside of the brain is shown above. Find the **medulla** (*muh-DUHL uh*). The medulla controls the activities listed below. Put a circle around YES if you have to think about doing that activity. Circle NO if you do not have to think about it.

Breathing	*YES*	*NO*	*Digestion*	*YES*	*NO*
Heart beating	*YES*	*NO*	*Coughing*	*YES*	*NO*

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) identify and label the medulla on a cross-section diagram of the brain.
(2) describe some functions of the medulla.
(3) identify and label the cerebellum on a cross-section diagram of the brain.
(4) describe some functions of the cerebellum.
(5) identify and label the cerebrum on a cross-section diagram of the brain.
(6) describe some functions of the cerebrum.
(7) identify and label the hypothalamus on a cross-section diagram of the brain.
(8) describe some functions of the hypothalamus.
(9) name the four most important parts of the brain.

Materials for Each Group

charts and/or models of the brain
stopwatch or clock with second hand
pencils

Time

Three days

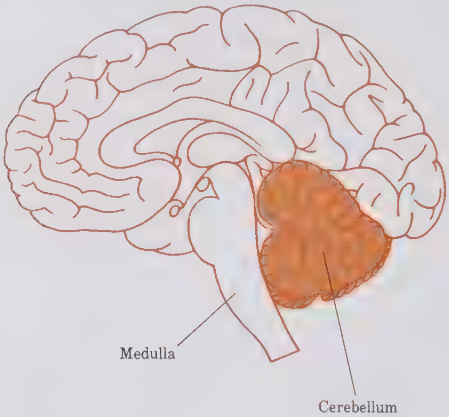
1. Functions of the brain have been discovered through research and by studying brain injuries. For example, damage to one part of the brain will result in speech difficulty. Damage to another part of the brain will result

→ H 216

Think about the answers you just circled. Now try to write a sentence that tells what kind of activities the medulla controls. Those activities that we don't think about. Involuntary.

3\.

Part Two The Cerebellum



Look at the picture of the brain and find the cerebellum (*SEHR uh BEHL uhm*).

Raise your hand and make a fist. You just did a complicated job. Your cerebellum directed it. How many muscles do you think you used when you did this job? Let students speculate.

Did you have to think about making all these muscles work together when you raised your hand? No.

When you walk, ride a bike, thread a needle, play basketball or write, you are using many muscles that must work together. Do you have to think about making them work together? No.

in memory loss. You might use the diagram of the brain to have students predict the result of an injury to specific areas of the cerebrum.

2. Part One Medulla. If a student reminds you that he can sometimes control a cough, try to get him to see that he is using the thinking part of his brain to do so. He can also decide to "fake" a cough. Most automatic responses that we'd call reflexes are controlled by the spinal cord.

3. Part Two Cerebellum. The decision to walk, to ride a bike, or write comes from the cerebrum. The coordination of the muscles is controlled by the cerebellum. Students will realize how important good coordination is in athletics. Spend a few minutes discussing this. You might point out that when a baby toddles, it hasn't yet developed the muscular control it needs to walk. Alcohol affects the cerebellum, hence the staggering drunk. Ask students what other things affect the cerebellum.

The students may need help to realize that we have little or no trouble balancing the body so long as our eyes are open, because we orient ourselves to other objects around us.

4. Part Three Cerebrum. You might want to point out that the human brain is larger and has more convolutions than any other animal's brain. If the second line to each "poem" is the traditional one, it was remembered from the past. Don't show surprise if some students don't know nursery rhymes. Foreign students, of course, will not. Spanish-speaking students may know only the Spanish line.

From your answers above, write a sentence that will tell one job that your cerebellum does. Coordinates muscles.

Now stand up, place your feet together and your hands by your side. Close your eyes. Stay in that position for two minutes. Ask a class member or your teacher to be timekeeper.

Could you stand perfectly still? No. How did you feel?

Accept student's description.

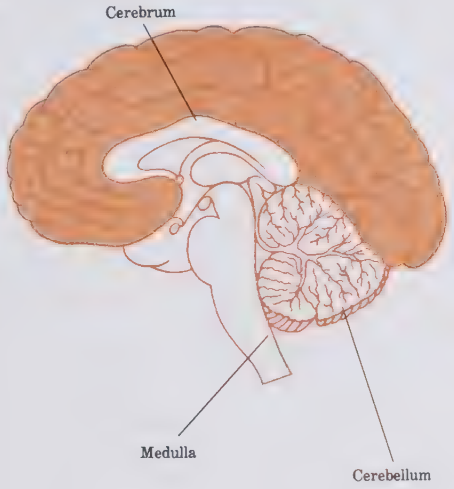
Your cerebellum was doing a different job this time. Write a sentence that will tell what this other job is. Helps keep the body in balance.

H 217

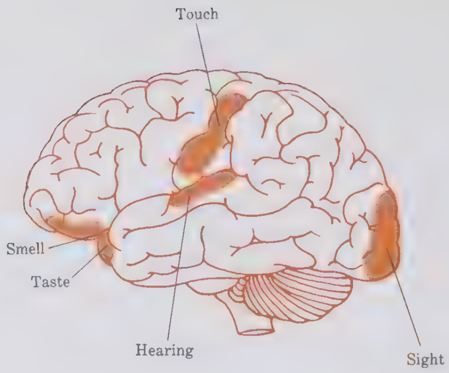
Part Three The Cerebrum

4.

Look at the brain and find the **cerebrum** (*suh REE bruhm*). About how much of the brain is cerebrum? Let student speculate. Actually it is 7/8ths of the brain.



In answering these questions the students may show talent, originality, and a sense of humor. Point out that this creative activity shows a high level of mental ability and is a different kind of thinking than remembering, which it also involves.



Scientists know less about the cerebrum than other parts of the brain. But you can look at the picture of the brain and list some of the jobs that they know the cerebrum controls. **Student lists information from diagram.**

There are other jobs that the cerebrum controls. Here are some of them: solving problems, remembering, learning, understanding language, and controlling movements.

Add another line to each of the following lines:

Roses are red, violets are blue
Accept any line.

Humpty Dumpty sat on a wall
Accept any line.

Jamti Damti se sentó en un muro
Accept any line.

In many high schools far and near

Accept any line.

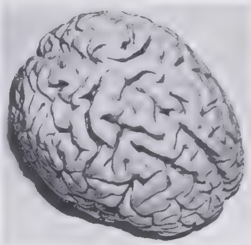
Compare your rhyming lines with those of at least three other students in your class. Were any of your answers the same as theirs?

Which ones? Varies.

← H 218

Can you explain why some people gave the same answers? They already knew the rhymes.

Why were some of your answers different from those of your classmates? Some students made up answers. Some knew the rhymes once but forgot them.



The outside of the brain shows the wrinkled cerebrum.

Were you able to write another line of the Spanish verse? Why?

Varies.

You used your cerebrum to find rhyming lines. Some of the answers had been stored in your memory for years. Give other examples of information that has been stored in your cerebrum for years. Let student speculate. Examples may include how to do math, history facts, their address, etc.

Did your memory help you with the last rhyming line? No.

How did your cerebrum help you rhyme the last line? By thinking creatively.

H 219

5. Part Four The Hypothalamus

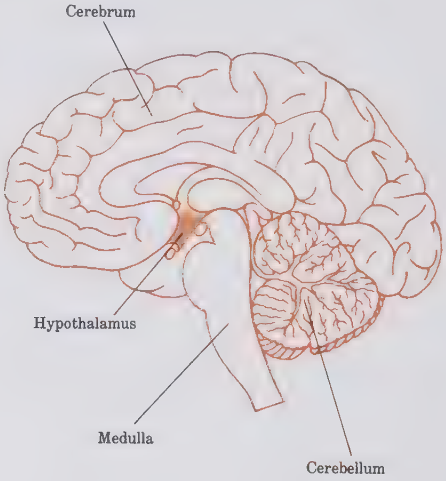
The kid sitting next to you takes your pencil. When you ask for it, she snaps off the point and throws it onto the floor. How do you respond? Answers vary.

On your way home, a huge dog jumps out at you and traps you against the wall. How do you respond? Answers vary.

Did you have to think about your responses and tell yourself to respond in that way? No.

Your **hypothalamus** (*hy poh THAL uh muhs*) helped you to do these things. It is another part of the nervous system that you do not control. But when you are in danger or angry, this part tells your **adrenal** (*uh DREE nuhl*) glands to put out more **adrenalin** (*uh DREHN uh lihn*).

Adrenalin goes into your blood. It speeds up your breathing and pulse. It makes the liver send extra sugar to your cells. And it makes the blood clot faster in case you are wounded.



5. Part Four Hypothalamus. Have students give other examples of situations when they use this part of the brain.

Look at the picture of the brain and find the hypothalamus. Now write a sentence that tells how your hypothalamus helps you in an emergency. Stimulates the flow of adrenalin which speeds up breathing and the release of sugar to the blood.

Check Yourself

1. What are four important parts of the brain? Cerebrum, cerebellum, medulla, hypothalamus.

2. Which part is used in each of the following cases?

You decide to telephone a friend. Cerebrum.

You remember the friend's telephone number. Cerebrum.

You see the telephone. Cerebrum.

You use your muscles to dial the number. Cerebellum.

You think of something to say and then say it. Cerebrum.

You are digesting an apple while you talk. Medulla.

You listen to your friend's reply. Cerebrum.

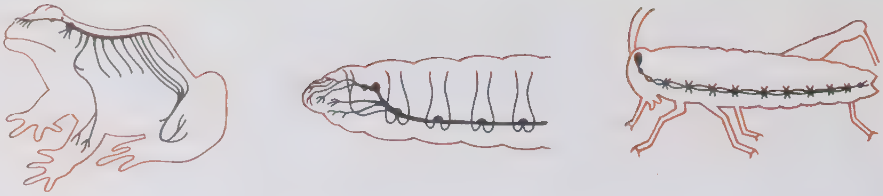
You don't like what he says, and you get mad. Hypothalamus.

You find that you are breathing faster. Hypothalamus.

3. A person who has taken drugs (especially alcohol) may have trouble walking or driving a car. What part of the brain has been affected when this happens? Cerebellum.

4. A person who has taken drugs may have trouble thinking and making decisions. What part of the brain has been affected when this happens? Cerebrum.

← H 220



How are these animals' nervous systems different from yours?

Research You Can Do

You may want to dissect a brain that is like yours. Brains of cows, sheep, and pigs can be bought or ordered from a butcher shop or the meat department of a supermarket.

Exploration 3. Sensing the World

Overview

In this Exploration the students explore some of the ways sense organs are used. The format for the chart in Part One may not be as simple for the student as it seems. The chart should be constructed to make it possible to compare the flavor of the candy with the nostrils closed and the flavor with the nostrils open. Brief activities in hearing, seeing, tasting, and smelling are included. The class has already done some experimenting with the sensory nerves in the skin.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) demonstrate that smell augments taste.
(2) compare hearing sensitivity in different individuals.
(3) describe some characteristics of human vision.
(4) discuss some limitations of human senses.

Materials for Each Group

3 packages of Life Savers
paper toweling
scissors
pencils

3. Sensing the World

When bats go flying, they squeak all the time. If a squeak bumps into a tree or insect, the squeak bounces back to the bat like an echo. Bats have big ears to listen for these tiny echoes.

← **H 221**

THE NOSE, tongue, ears, eyes, and skin are called sense organs. They pick up stimuli and send messages to the brain. The brain's job is to understand the messages.

In today's lesson you will explore the senses and some of the messages they send to your brain.

1. Part One Your Nose Knows

Work with another person. One person will take the tests and the other will give the tests and take notes.

Spread four or five different flavors of Life Savers on a piece of clean paper. Cover them so the person taking the test can't see them. Suppose the person taking the test is a girl. She must hold her nose and close her eyes. Put a Life Saver into her mouth.

water
meter sticks (3 or 4)
three pans
stapler

Time

Three days

1. Part One Although Life Savers are called for, any hard flavorful candy can be used. Some packages of assorted candy can be split into two parts. Be certain that there are at least four different flavors for each pair of students. Students may realize that their sense of taste is impaired when they have a "stuffy" nose. Allow each group to devise its own charts.

A fly tastes sweetness with its feet, not its mouth. That is why flies like to land on sugar.

While she is holding her nose, can the taster tell what flavor the Life Saver is? No.

Can she tell that it is sweet? Yes.

Tell the taster to let go of her nose. Can she taste the flavor now? Yes.

Can she taste the sugar? Yes.

Try this test three or four more times. The taster should take a drink of water after each Life Saver. Put the results on the chart.

Flavor of Life Saver	Holding Nose	Not Holding Nose	Sweetness?
	Answers will vary.		

What does the chart seem to show? That the sense of taste depends on the sense of smell. But sweetness can be detected by the tongue alone.

→ H 222

2. Part Two Hear Here

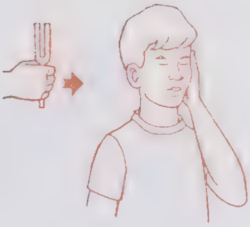
Work with someone else. One student will take the test and the other will give the test and take notes. Or work in groups of three, and have one person just take notes. Work far enough away from other groups so your results will not be mixed up with theirs.

Have the student taking the test sit in a chair, and close his eyes. He should hold a hand over his left ear. The person giving the

2. Part Two The sound that should be listened for is the "hum" of the tuning fork. This can be heard only when it gets quite close. Make sure the groups stay away from each other and work quietly. If this is not possible, have one group demonstrate for the class.

3. Part Three Point out that depth perception is important in making judgments when driving a car. A person with one eye is handicapped in this area. Get the class to contribute ideas about how advertisements and packaging goods can fool the eye. Students may want to draw an original series of pictures and make their own "movie."

test should take a tuning fork and stand about a meter away.
Strike the tuning fork lightly to make it vibrate. Slowly move it closer to the right ear of the person being tested. As soon as the person hears the tuning fork, stop moving.



Measure the distance between the ear and the tuning fork. Write the distance here. Varies.

Test the left ear in the same way. Measure the distance from the tuning fork to the left ear. Write the distance here. Varies.

Compare the person's hearing in his right ear and left ear. Varies.

Did everyone in the class get the same results? Varies.

3. Part Three See It — Don't Believe It

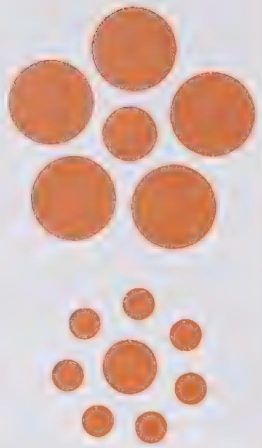
You can't always believe what you see. That is one reason why scientists measure things. Try out the sights on the next page and see if they fool you. Do it now. Then come back and read the rest of this page.

Your brain still sees a picture for a little while after it has disappeared. That is why you don't notice the separate frames in a movie. Movies are made up of a series of still pictures.

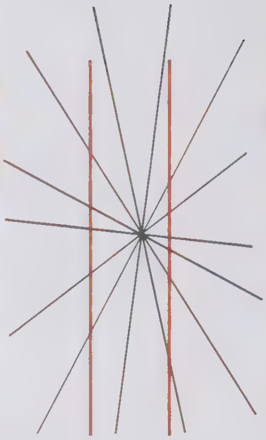
Cut out the pictures of the Keystone Cop on page 327. Put them in order and staple them together to form a booklet. Then trim the right hand edge of the booklet very carefully with a scissors or a knife.

Flip the pages between your fingers. What do you see? Figures seem to move.

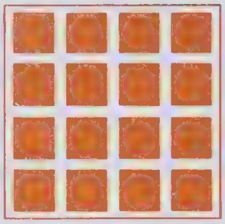
How are the pictures drawn to give you this effect? Each frame shows the action at an advanced stage.



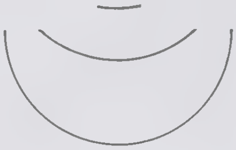
Which of the balls in the center is bigger?



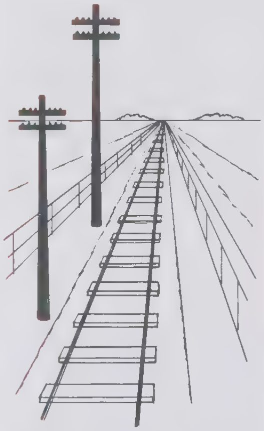
Are the red lines straight or curved?



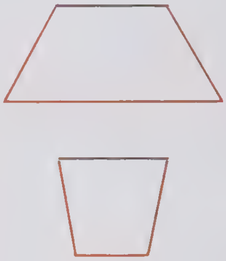
Do you see dark spots where the white lines cross?



Could these three lines be part of one circle?

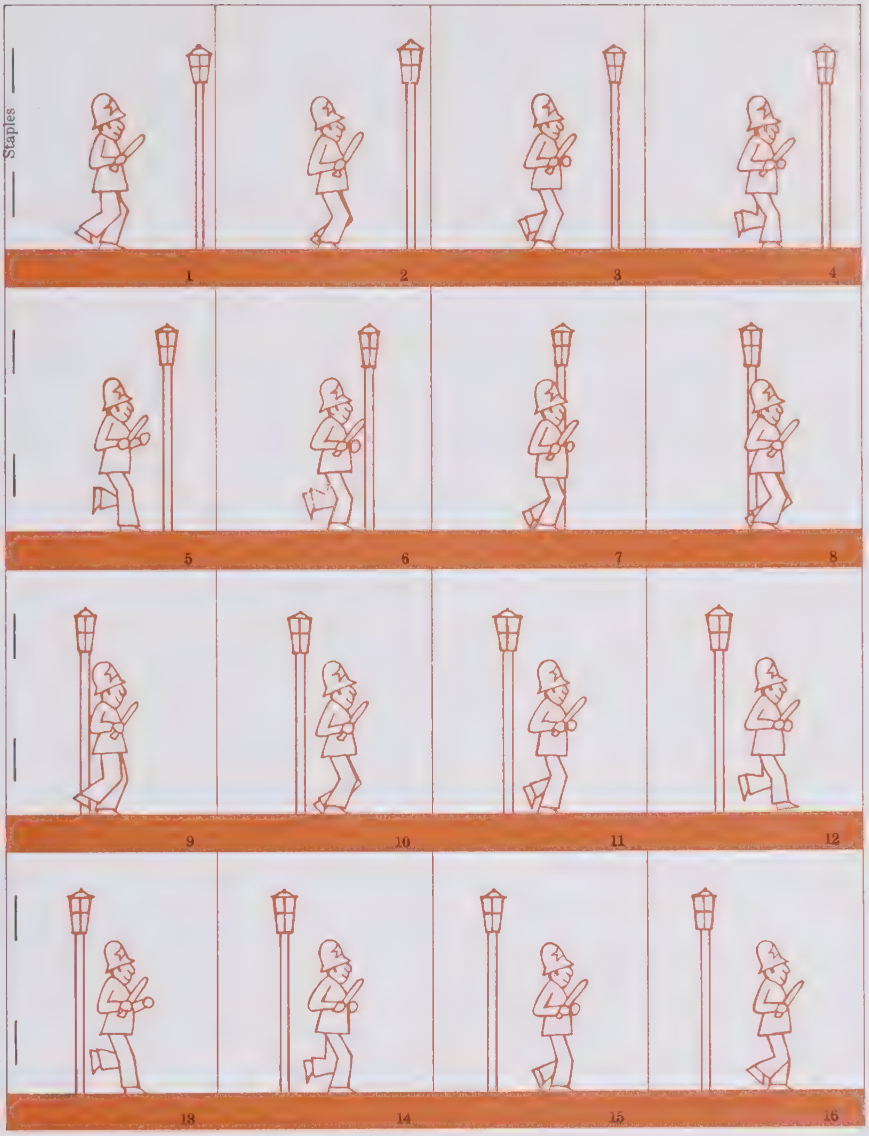


Is one telephone pole bigger than the other?

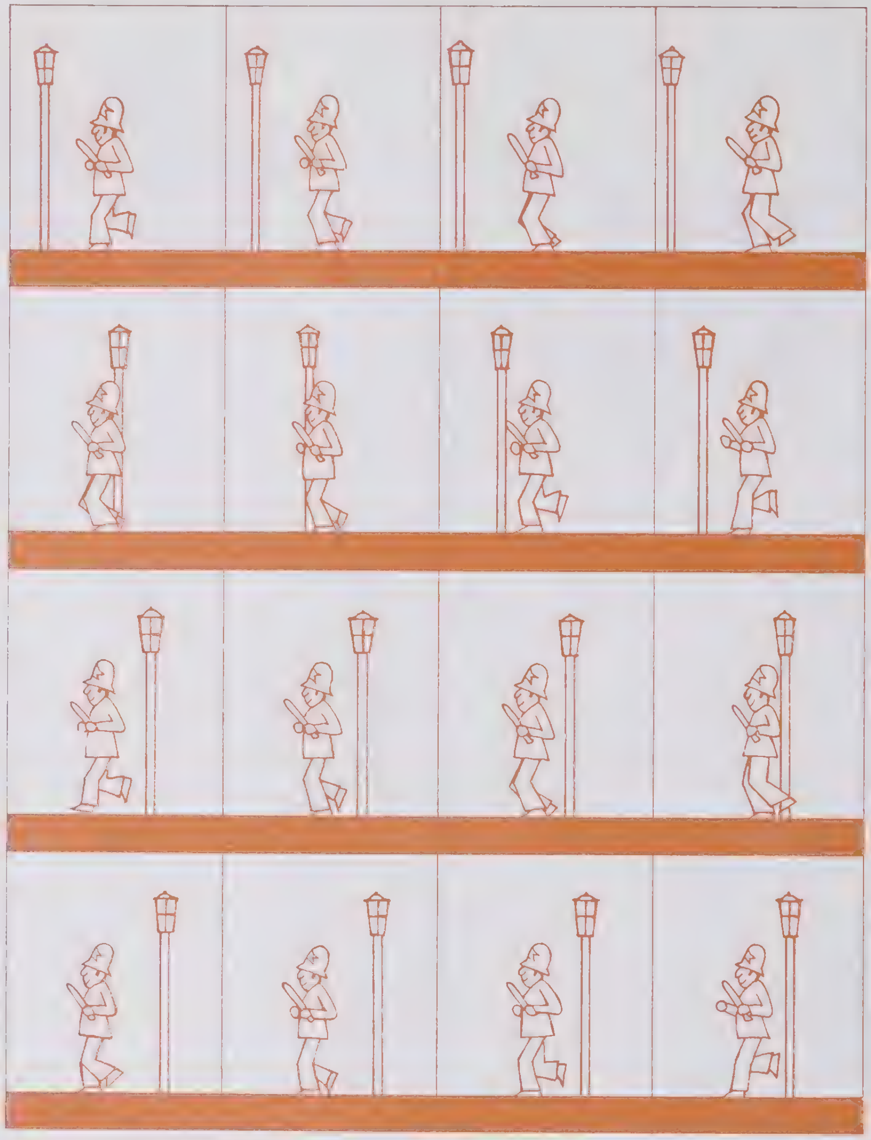


Are the black lines the same size?

Hard cover users: To reproduce the pictures of the Keystone Cop for this Exploration please turn to page T 64 or direct students to the Laboratory Supplement.



T404



Hard Cover Folios Preceded by H

Two eyes are better than one. If you don't believe it, hold a pencil in each hand and put your arms as far apart as you can. Close one eye. Bring your hands together and try to make the ends of the pencils touch.

Try the same thing with the other eye closed.

Try the same thing with both eyes open.

What did you find out by doing this test? That two eyes give you better depth perception.

← H 224

Part Four In Hot Water

Your group will have three pans. Label them A, B, and C.

Fill pan A with cold water.

Fill pan B with warm water.

Fill pan C with hot water
(not too hot to touch).

Take the temperature of each pan of water and write it down.

Temperature of pan A Varies.

Temperature of pan B Varies.

Temperature of pan C Varies.

Put one of your hands in the water in pan A and the other hand in the water in pan C. Keep your hands in the pans for two minutes. Now put *both* hands in pan B.

How does the hand that was in pan A feel? Student records.

How does the hand that was in pan C feel? Student records.

Is there a difference? If so, can you explain it? Student records information.

Does your skin tell you the same thing a thermometer does? No, because the skin "remembers" recent temperatures, which a thermometer does not.

Can your skin be fooled about temperature? Yes.

Research You Can Do

Other mammals have eyes that are much like our own. Dissect the eye of a sheep or cow. Use charts and models to help you find the parts.

If you would like to understand your senses better, you could try reading one of these books: *Experiments in Optical Illusion* by Nelson F. Beeler and Franklyn M. Branley, *Understanding Your Senses* by Ann B. and James A. Gilmour, *Taste, Touch and Smell* by Irving and Ruth Adler.

Use Your Wits!

This is a game of *Concentration.*

Cut out the cards on the next page. Notice that the cards with colored backs show parts of the brain. The other cards show activities.

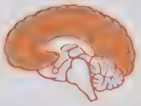
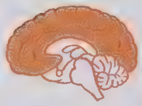
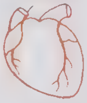
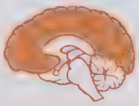
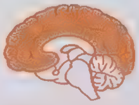
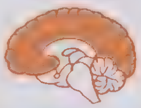
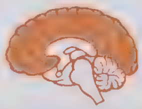
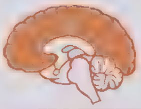
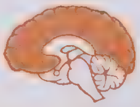
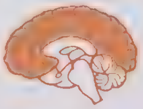
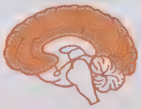
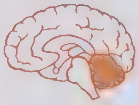
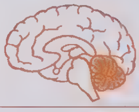
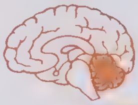
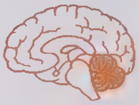
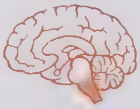
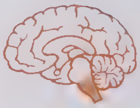
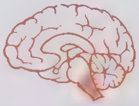
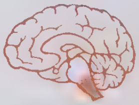
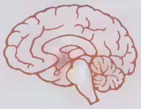
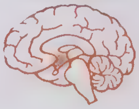
Put the cards face down on your desk. Put the white cards in two rows on the left and the colored cards in two rows on the right. Turn a white card and a colored card over. If the two match, pick them up and keep them. Then try for another match. If the cards don't match, put them face down in the same place and let your partner try.

Suppose you think a pair of cards matches, but your partner does not. Look up the right answer. If your partner was right, he or she gets an extra turn.

At the end of the game, the person that holds the most cards is the winner.

It might be fun to make one big game by using two or more sets of cards.

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 43 or direct students to the Laboratory Supplement.

Hearing 	Touching 	Cerebrum 	Cerebrum 
Breathing 	Heartbeat 	Cerebrum 	Cerebrum 
Thinking 	Coughing 	Cerebrum 	Cerebrum 
Digesting 	Bike riding 	Cerebrum 	Cerebrum 
Seeing 	Being angry 	Cerebrum 	Cerebrum 
Memory 	Tasting 	Cerebellum 	Cerebellum 
Walking 	Balance 	Cerebellum 	Cerebellum 
Throwing a basketball 	Being frightened 	Medulla 	Medulla 
Smelling 	Solving a problem 	Medulla 	Medulla 
Talking 	Planning 	Hypothalamus 	Hypothalamus 

11 The Frog and You

H 225

H 226

Exploration 1. Learning from a Frog

Overview

A high point in many biology courses is the frog dissection. Since the structure of a frog is similar to a human's, this activity serves as a review of the last several lessons on anatomy and physiology. The check-off method makes it easy for the class to follow directions and be sure that nothing is skipped. Hard cover users should have their students prepare a list of direction numbers to check off as they complete the activity. As you move from group to group, question the students about what they are doing. Be sure that everyone is involved, not just the one who is dissecting.

The activity helps students review what they know about the anatomy of the digestive, circulatory, excretory, respiratory, and nervous systems. They also studied the frog's behavior earlier in the year and may remember some external anatomy.

One of the general objectives of Life: Activities and Explorations is to help students "develop an appreciation for life in all its forms." We have generally avoided activities that result in the loss of living things. We are making an exception with this frog dissection because it offers many students the only chance they will ever get to carefully look at the internal structure of a vertebrate similar in many ways to themselves.

You should explain this point to the students. Tell them that there is really no other way to achieve the important goals of the activity, and that they should respect other living things—large or small, simple or complex—in-

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Exploration

1. Learning from a Frog

1. When you cut a plant or animal apart to study it, that's called **dissecting** (*dih-SEHKT-ihng*) it. You dissected a heart when you studied circulation. Today you will cut open or dissect a frog. A frog's insides are not exactly like yours. But you can learn a lot about your body by studying a frog's body.

Each group may get a freshly killed frog. When you get the frog, it will be dead. When an animal dies, not all of its parts die at the same time. Some of the parts of your frog may still be alive. The legs and eyes may move, the heart may beat, but the frog cannot feel any pain. Soon, even these simple actions will stop.

2. Part One Start on the Outside

Put a (√) next to each number after you do that part of the lesson.

( ) 1. Find the frog's nostrils.

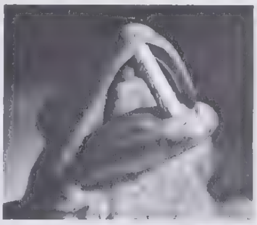
( ) 2. Find the eardrums. They are just behind the eyes. When the eardrums pick up sound vibrations, they send a message to the brain.

( ) 3. Use a piece of matchstick to hold the frog's mouth open.

( ) 4. Can you see any teeth? Two on roof of mouth.

( ) 5. If you want to, touch the inside of the jaw. Can you feel any teeth? Fine teeth along upper jaw only.

( ) 6. Lift the tongue with the forceps. How is the frog's tongue different from yours? Attached in front, forked end, white, sticky, long, flexible.



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cluding plants. Help them to have a sense of their community with all the other living things on the planet.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) dissect a frog.

(2) name at least five anatomical parts of frogs and humans.

Materials for Each Group

frogs
dissecting pan
dissecting tools
match stick
forceps
pins (straight)
charts and models (optional)

Time

Three days

1. This activity is planned to be used as a review of the work on anatomy and physiology. Freshly killed frogs are best to use, so plan to have living frogs available a day or so before the lesson. Pithing a frog will kill it by destroying the brain and spinal cord. The frogs can be killed also by over-etherizing them, but unless this is done about forty-five minutes before class time, there may be no heartbeat. If less than one-half hour is allowed,

( ) 7. How could this kind of tongue help the frog catch its food?

Food sticks to it and is easier to swallow.

( ) 8. What are the colors of the frog's skin? How do these colors help the frog hide from its enemies? Describe colors. The frog is camouflaged from above and below.

( ) 9. How are the frog's back legs different from its front legs?

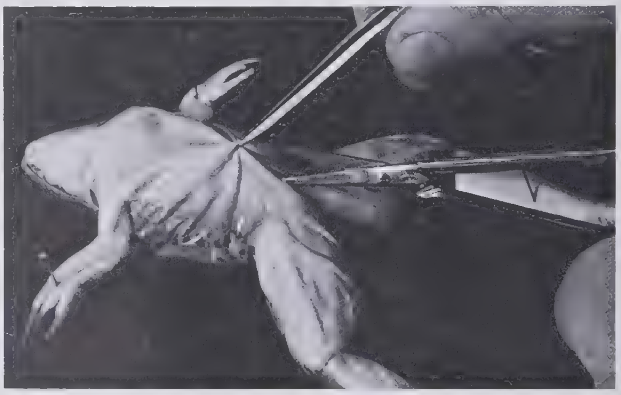
Longer, more muscular, and webbed.

3. Part Two The Internal Organs

( ) 1. Place the frog on its back (belly side up) in a **dissecting pan**. Pin the four legs to the wax in the bottom of the pan.

→ H 229

( ) 2. Use the forceps to lift the loose, thin skin of the belly. Take the scissors in your other hand. Start between the back legs and carefully cut along the belly to the chin.



the etherized frogs may not be dead. Of course, it is possible to use preserved frogs.

The class can work as individuals or in groups, depending on the number of frogs available. Some students will want to dissect while others would rather look on. One or two may want to do neither. Don't insist that unwilling students touch (or even watch) the frog. Plan another exercise for them that will not require your attention.

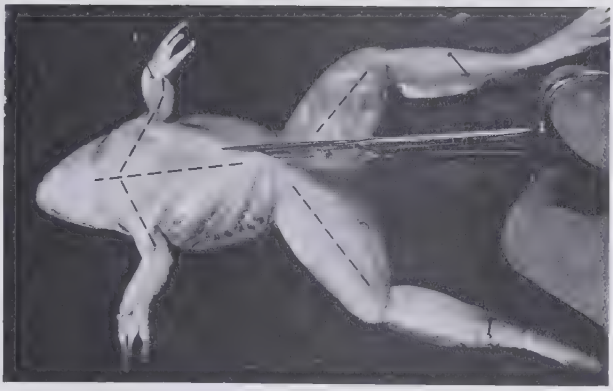
2. **Part One** Remind the class that they observed living frogs in an earlier Exploration.

3. **Part Two** Assure the students that the frog is dead even if the heart is beating. Often the heart can be started by dropping three or four drops of adrenalin on it. If the heart is beating try this activity. Soak cigarette tobacco in water for about one-half hour. Then put three or four drops on the beating heart. Wait a minute. Count the number of times the heart beats in one minute. Ask students what effect tobacco has on a frog's heart.

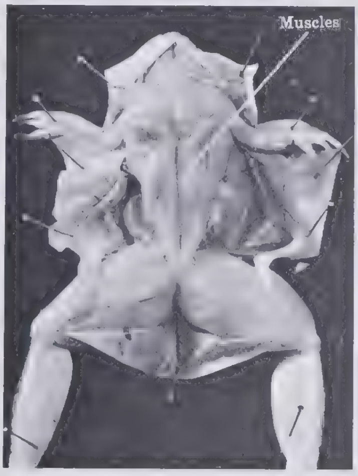
To keep the frogs for more than one day, put the specimens for each class in a plastic bag and place them in a refrigerator.

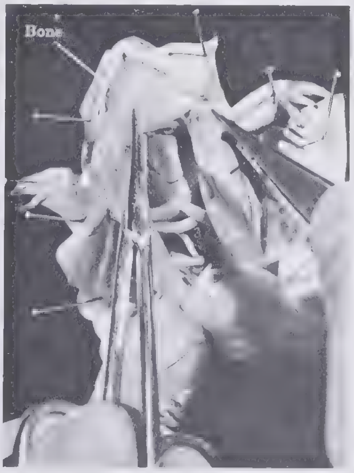
Allow time for cleaning up! Dissecting tools should be washed, dried, and mady ready for use again.

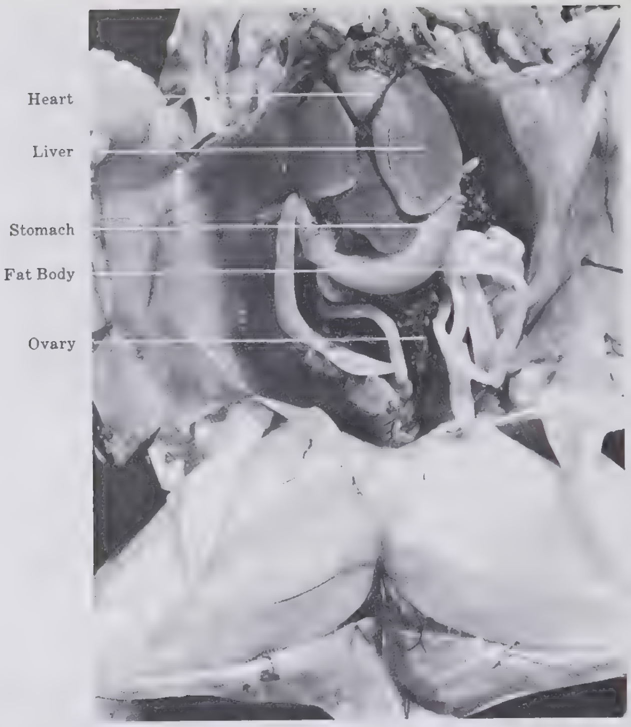
Reminders: Obtain or order the following items for Chapter 12.: planarians, flowers, and chick eggs.



( ) 3. Make side cuts toward the four legs.
( ) 4. Pin back the flaps of skin to the pan.
( ) 5. Now you can see the layer of body muscles. Use the forceps to lift the muscles. Cut through the muscles the same way you cut through the skin. *Be careful not to cut into the body parts just below the muscle layer.*
( ) 6. When you get near the front legs, cut through the hard bone that lies between them.







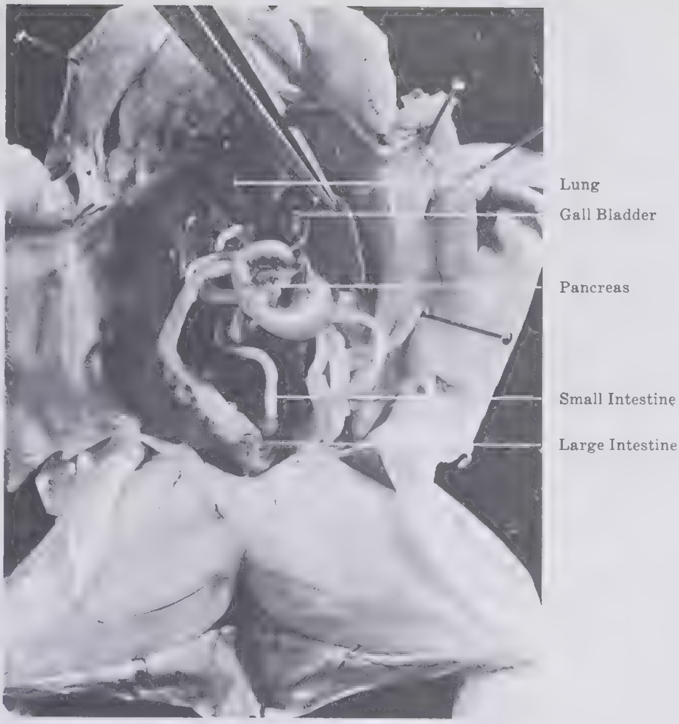
( ) 7. Pin back the body muscles to the pan.

( ) 8. Now you can see the inside of the body. Look for the heart. The thin covering on the heart is called a membrane. Carefully cut away the membrane.

( ) 9. Is the heart still beating? Varies. If it is, count the number of times that the heart beats in a minute. Varies.

If you cannot finish the dissecting in one period, this is a good place to stop. Take the pins out of the frog. Pull the muscle and skin flaps back over the open belly. Wrap the frog in a wet paper towel. Put your name on the package and put it in the refrigerator. When you are ready to finish the dissecting, unwrap the frog. Put it back in the dissecting pan. Pin back the legs, the skin, and the muscle flaps. Then go on with the lesson.

→
H 230

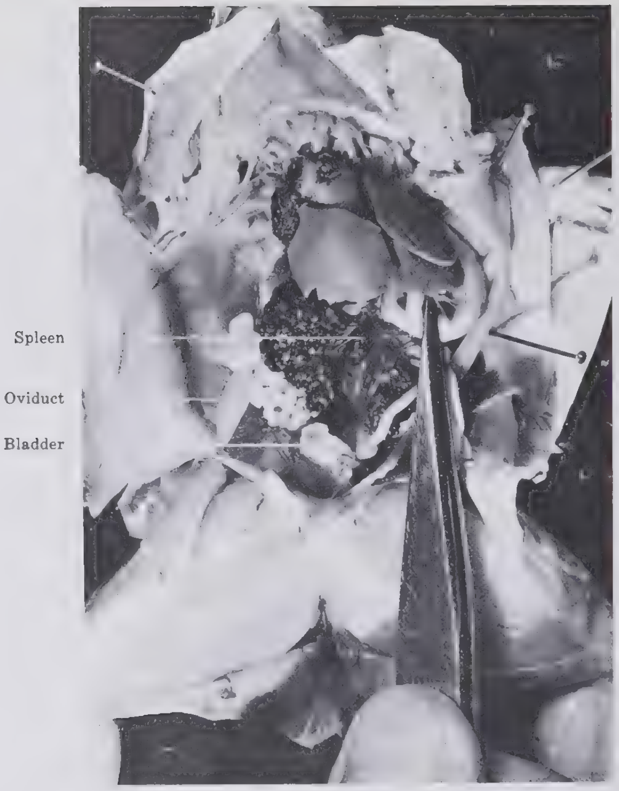


( ) 10. If you have a female frog, you will see her **ovaries** (*OH-vahr-ees*). The ovaries are the parts that make the eggs. They may contain lots of black and white eggs. Take out the eggs and put them in the pan. If you do not have a female frog, be sure to look at one in another group.

Now try to find these parts:

( ) 11. liver
( ) 12. stomach
( ) 13. small intestine
( ) 14. large intestine
( ) 15. two lungs (under the liver)
( ) 16. gall bladder (lift the sections of the liver)
( ) 17. pancreas (The pancreas sends enzymes into the small intestine to help in digestion. It is under the liver, in a bend of the small intestine. It may be hard to find.)

← H 231



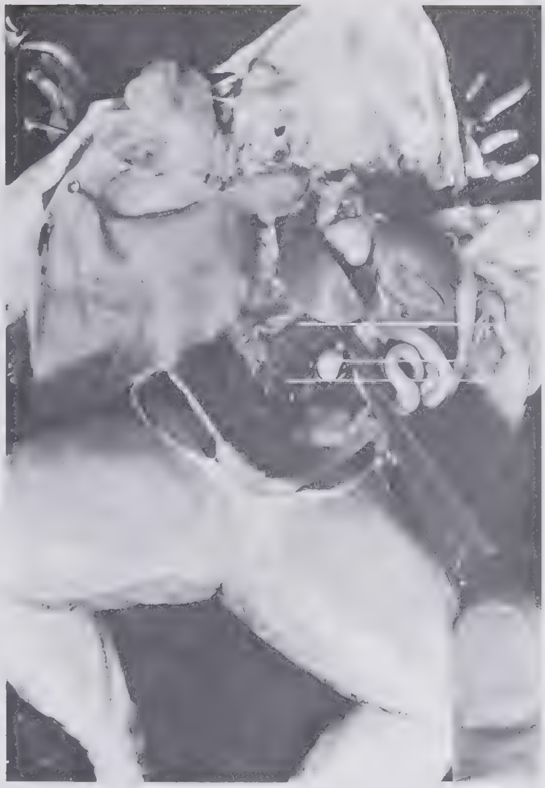
( ) 18. urinary bladder

( ) 19. Take out the digestive tube by cutting it near the head and near the end of the large intestine. You will be taking out the gullet, stomach, small intestine, and large intestine. Take out the liver, also. Put these parts in the pan.

Now look for these parts:

→ H 232

( ) 20. two oviducts (These are found in the female frog. They are the tubes that carry the eggs when they leave the ovaries. In some kinds of frogs, small oviducts can be found in the male frog.)



( ) 21. spleen (The spleen helps protect the body by removing germs from the blood. It also stores red blood cells until the blood needs them.)

( ) 22. two kidneys

( ) 23. two testes (These are found only in the male frog. They make the sperm cells. If you do not have a male frog, be sure to look at one in another group.)

( ) 24. two adrenal glands (They may look like gold streaks on each kidney. They produce the adrenalin that helps the body respond quickly to an emergency. If you can't see the adrenal glands on your frog, look at another one.)

← H 233

→ H 234

If you have time, go on with your dissecting. Take out an eye and study its parts.

Look into the mouth and find the opening that leads to the lungs. Put a glass or thin plastic straw into this opening and blow gently. This will fill the lungs with air.

Take all the skin off the back legs and study the strong leg muscles underneath.

Take out all the organs. Find the white nerves that come from the spaces between the bones of the spine.

Check Yourself

1. What parts did you see in the frog that are also in your body? List as many as you can. Heart, lungs, kidneys, among others.

2. How is the inside of a frog different from the inside of your body? It has no diaphragm, has a three-chambered heart; the female has an egg mass, the male has an oviduct and testes in body cavity.

3. How were the male and female frogs different? Female has eggs and large oviducts. Male has two testes. Mature male has large black thumb.

4. Guess how many eggs were in the body of the female frog you looked at. Accept any large number (hundreds).

Use Your Wits!

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 45 or direct students to the Laboratory Supplement.

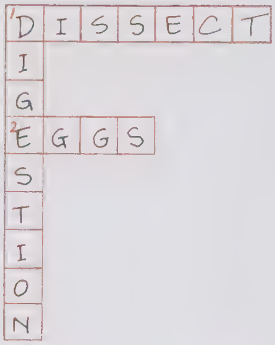
Use what you learned this year to help you solve the puzzle on the next page. Use the clues below to fill in the puzzle.

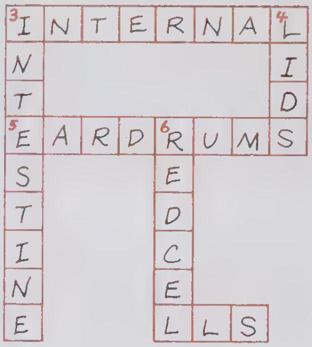
Across

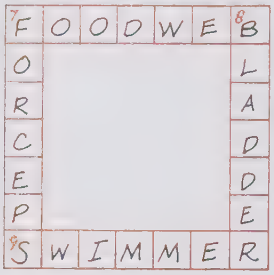
1. Cut open
2. Female frog lays hundreds of them
3. Inside
5. Parts of the body that pick up sound vibrations
7. Group of food chains
9. To live in water, the frog must be a good ___________.
10. The sex that has testes
11. The part of the male's body that makes sperms
13. The part of the body that stores red blood cells
14. A large dark red gland that has three parts
15. All living things get energy from the ___________.
16. A frog has ________ . __ lungs.
18. An organ that takes liquid waste out of blood

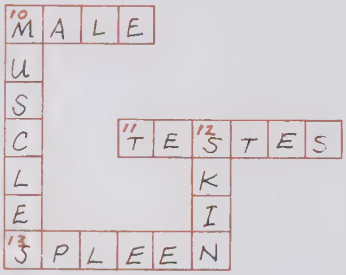
Down

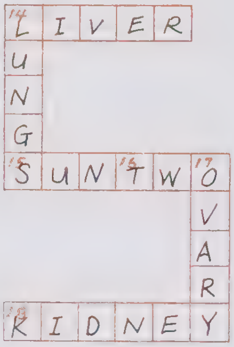
1. The breaking down of food
3. Food goes from the stomach to the small ___________.
4. The frog has extra eye ___________.
6. They carry oxygen in the blood
7. A tool used in dissecting
8. Where urine is stored
10. These parts of the body move the bones
12. The outer body covering
14. Organs that take oxygen out of the air
17. The part of the female's body that makes and stores eggs


1 DISSECT
1 DIGESTION
2 EGGS


3 INTERNAL
3 INTESTINE
4 LIDS
5 EARDRUMS
6 REDCELLS


7 FOODWEB
7 FORCEPS
8 BLADDER
9 SWIMMER


10 MALE
10 MUSCLE
11 TESTES
12 SKIN
13 SPLEEN


14 LIVER
14 LUNG
15 SUN
16 TWO
17 OVARY
18 KIDNEY

Overview of Unit Three How Living Things Reproduce

Reproduction is a popular topic with most high school students. We move from the simple methods of reproduction to the complex, and use a variety of living things in the laboratory work (Chapter 12).

Three very different kinds of living things, the fungi, the angiosperms, and an animal, are used in the laboratory work from which the students learn about asexual reproduction. These lessons demonstrate that there is a variety of methods of reproduction among living things. You may want to point out that an organism's method of reproduction has helped it survive as a species.

As you work on regeneration and plant propagation, careful planning is necessary to organize materials and lessons so that no time is wasted. You will have to wait for growth to take place. Reading, Research You Can Do, Hall of Fame, and films can be used if there is time left after data have been recorded each day.

Sexual reproduction is introduced with Readings that should be assigned. Hopefully by this time the students have caught on to using the reading as a source of answers to the questions on the laboratory sheets. Remember that improving reading skills is an important goal of this course.

A laboratory lesson on the flower and one on the development of a chick follow. Plan ahead to be sure that the chicken eggs are incubated for the proper length of time. It is fun to keep a few in the incubator for the full twenty-one days and watch the chicks hatching. If you do this, be sure that the twenty-first day does not fall on a weekend or holiday.

As a change of pace as well as to familiarize the student with another way of learning, human reproduction is handled as a programmed lesson (Explorations 10, 11, 12). There is a formal vocabulary that should be learned and the program simplifies this task. The illustrations were carefully chosen to give flexibility to the material. The class, or individual students, can use them as a guide to more discussion. There may be problems, such as teenage pregnancy, venereal disease (which will be covered in Chapter 16), homosexuality, or prostitution that you feel are appropriate topics to be brought out in the open with your class.

Genetics (Chapter 13) is another area in which much of the "old reliable" subject matter has been purposely left out. Punnett squares are not relevant to the nonacademic students. If they know that a recessive trait may appear in a future generation, there is no practical reason for them to figure that the chances may be one in four. However, in the world of tomorrow, a citizen should have at least a "talking" knowledge of the biological code.

We use humans as a reference point for variation (again, some graphing) and inherited traits. This technique is meaningful for students, but remember that their family background may be unconventional, and do not put too much stress on explaining the results.

By the time we are ready to teach evolution (Chapter 14), the students have been exposed to some of its ideas. For example, they know that animals that are best adapted to their environment are the ones that survive.

Fossil evidence is stressed in the activities on evolution. Again, the laboratory work provides the basis for an understanding of the subject matter. By making fossils and creating their own paper fossil bed, the class will learn some of the difficulties of piecing together the bits of information that archeologists find in fossil beds. They will also understand some of the evolutionary changes that have taken place.

Unit Three

How Living Things Reproduce

12 Reproduction

→ H 235

1. In their fifth year of life the king salmon begin going home. They are saltwater fish that live in the Pacific Ocean. But they need to lay their eggs in fresh water — in the same stream they were born in.

From hundreds of miles out in the Pacific, the salmon swim to the coast. They search out the mouths of rivers from California to Alaska. No one knows what makes them come in from the sea, or how they know where to go. But they come and they know.

The swim to the rivers is dangerous. Seals, sharks, and bigger fish prey on the salmon. Fishermen catch thousands of them. Some probably die from pollution.

The swim up the river is worse. The salmon have to fight heavy currents for hundreds of miles. There are dangerous rapids in the way and high waterfalls. The fish are pounded and scraped against the rocky riverbeds. Bears come down to the river to snatch them out. Eagles catch some. And there are more fishermen upstream. Most of the fish don't make it.

Reading 1. Offspring

1. Here is a place to reinforce what the class knows about inborn behavior and that it is unchanging and automatic.

The salmon don't eat as they struggle toward home. They live on stored fat. The nearer they get to home, the thinner and more battered they become.

But somehow, some salmon finish the long journey. They return to the same streams they were born in. The females lay their eggs. The males fertilize the eggs and cover them with gravel. Then both parents die, completely worn out.

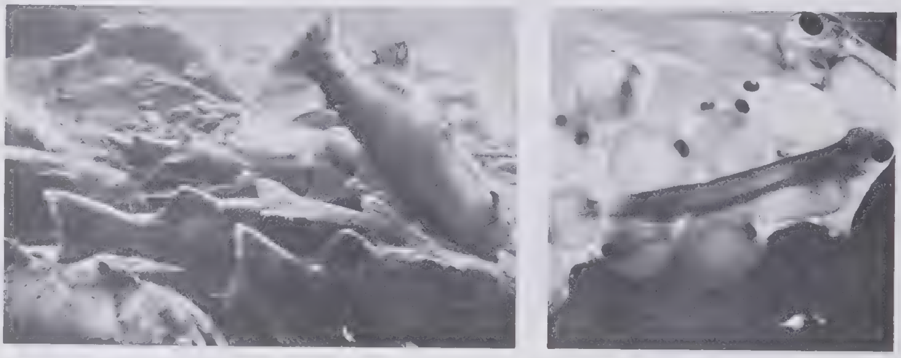
Baby salmon are born in clear and cold fresh water. They don't know how they got there. If they live long enough, an inborn urge will make them swim to sea like their parents. And in five years another urge will drive them to return home and mate in the same clear water. The struggles of the parents are passed on to their young.

Maybe no animal endures as much as the salmon to reproduce. But all living things make new individuals like themselves. Salmon, plants and animals in a drop of water, the bacteria that cause disease, fleas — they all reproduce.

Salmon produce more salmon. Horses produce more horses. And oak trees make more oak trees. No one is surprised at this. Yet salmon, horses, and oaks grow from single cells.

2-3. New life usually begins as one cell or a few cells. Each cell carries a set of plans. The plans make sure that the new individual grows to be the same kind of living thing as its parents. The plans are carried by a giant molecule called DNA. DNA is found in the nucleus of cells.

4. Some animals produce over a million offspring. A salmon lays thousands of eggs. A giant sea turtle crawls up a beach at night and lays a hundred eggs in a hole in the sand. Birds, cats, and pigs may have only four or five offspring at one time. And people usually have only one child at a time.



For king salmon birth and death go hand-in-hand.

2. Not only is the DNA for each kind of plant and animal different, but within each group of living things the code for individuals is different. Even brothers and sisters with the same parents have different DNA.

3. Scientists have figured out that the chances of there being another human being exactly like you (except for identical twins) is one out of several trillion—a number that we can't begin to understand.

4. The idea of variety is important. Later you will build on this idea when you talk about natural selection.

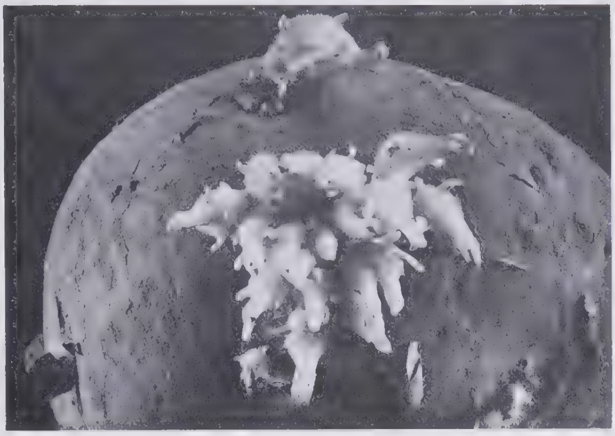
Exploration 2. When One Parent Is Enough

Overview

We recognize that by another scheme of classification molds and mushrooms would be called protists, but for the purposes of this program we divide all living things into two kingdoms.

The overproduction of spores in molds and mushrooms is obvious, and most students will realize that only a few survive. This is a concept that was mentioned earlier in the year when the living frog was studied and more recently when the frog was dissected. A reminder, prepare the yeast-sugar solution a day ahead of this activity.

Exploration
2. When One Parent is Enough



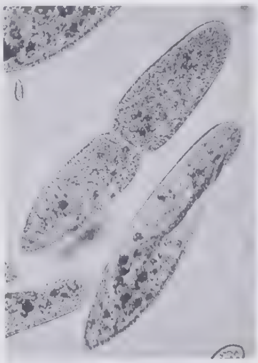
Potato eyes. The furry parts that look like mice are really roots.

1. MANY PLANTS and animals can produce new individuals from a part of their bodies. In some cases the part is large, and in other cases it may be microscopic. In any case, a whole plant or animal grows from just a piece. This is asexual (not sexual) reproduction.

The eye of a white potato isn't an eye at all. It is really a bud that can grow into a new potato plant. A stem cut from a willow or a geranium plant can form roots and become a new plant. Grass and strawberries send out special stems called runners. The runners will grow into new individuals. Bacteria divide in half to reproduce.

There are some advantages to asexual reproduction. Farmers and florists use asexual methods to grow plants that do not develop well from seeds. The white potato and the banana are plants of this type. Florists also use asexual methods to save time. It takes less time to root a cut stem than to raise a plant from a seed. Asexual methods are also good when a plant grower wants offspring exactly like the parent. If there is only one parent, the new generation will be exactly like that parent.

One-celled plants and animals can multiply by dividing.



Behavioral Objectives

After completing this Exploration, the students will be able to

(1) define or describe *asexual.*

(2) give one or more examples of asexual reproduction.

Materials for Each Group

fresh mushrooms
paper
glass (large enough to cover mushroom cap)
hand lens (optional)
microscope
yeast-sugar solution
slide
dropper
cover glass
bread

Time

Two days

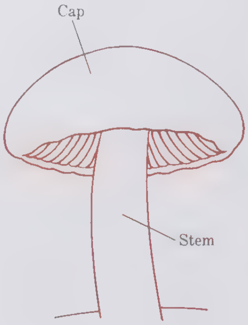
1. Make it clear that spores are different from seeds. Spores are unicellular and have one parent. Seeds have two parents.

The yeast-sugar solution should be prepared a day ahead. Put about one-fourth package of yeast in 250 ml of 5% sugar solution. The proportion of sugar to yeast is not critical, but prepare the mixture with warm water and keep it in a warm place to encourage budding.

Banana trees are grown from pieces of roots, not from seeds.

All plants can't be grown asexually. In this exploration you will see some that can.

H 240



2. Part One Mushroom Spores

Some simple plants produce millions of microscopic **spores**. Each spore is a cell. If it falls in a suitable place, it can grow into a new individual. Molds and mushrooms reproduce this way.

Remove the stem of a mushroom. Place the cap on a piece of plain paper. Cover it with a glass or a jar and leave it overnight where it won't be touched. The next day remove the glass. Very carefully pick up the mushroom cap.

What do you see on the paper? Pattern that resembles the inside of the cap (formed by spores).

Use a hand lens or a microscope to look at these spores. How many spores do you think there are on the paper? Thousands.

Can you rub the spores off the paper with your fingers? Yes.

2. **Part One** When buying mushrooms for this, choose those that have open caps. After this part is prepared, set it aside and do Part Three. The students may not realize at first that the pattern they see on the paper is made by spores.

3. **Part Two** Start this activity at home. If a student has a problem finding house room for his jar, find a spot for it in the classroom. You can add interest by suggesting the use of different kinds of bread—rye, whole wheat, Italian, or rolls—or try a mold race to see which student (or group) will collect the largest assortment of molds, or have a contest to see which group has the fewest types of molds by handing out half slices of fresh bread wrapped in waxed paper. Check at the end of a week for the most nearly mold-free slice. Oddly enough, bread with sodium propionate added will mold. Part Two will be completed after a week.

To make mold slides, pick off a small amount of mold from a piece of bread by using a dissecting needle. It can be put on a drop of glycerine and observed without a cover glass. Or, make a slide with water in the usual way.

Where did all these spores come from? From spore cases under the cap.

What might grow from each of these spores? Why do you think so?

A new mushroom. The spore is a reproductive structure.

What must happen to each spore before it can grow into a new mushroom plant? It must fall in a place where it can get food, moisture, limited light.

The small bumps on these fern leaves are spore cases.

← H 241

3. Part Two Grow a Mold Garden

Use a small piece of stale bread. Dampen the bread a little bit and put it in a jar with a cover. Take the jar home and place it in a warm, dark place for a few days.

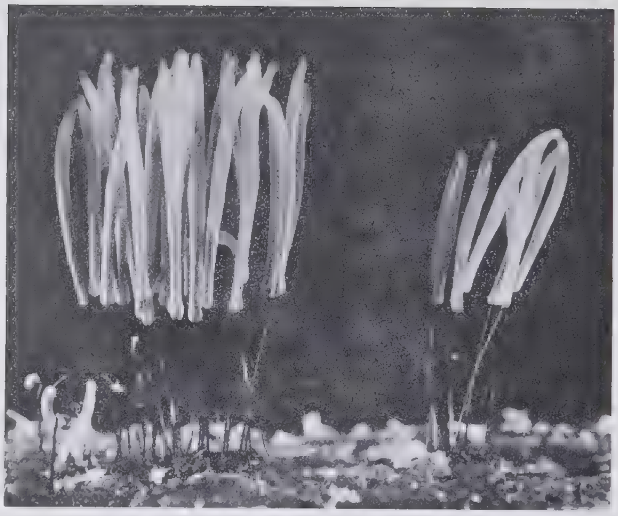
Look at the bread every day to be sure that it does not dry out. When mold starts to grow, you will see something that looks like white cotton on the bread. At the end of a week bring your jar to school, even if there has been no change. *Keep your jar covered to avoid spreading microscopic spores around.*

What do you see in your jar? Answers will vary.

How many different kinds of mold can you find by looking at all the jars in the class? *A hint:* Look for differences in color.

Answers will vary.

In one class the students found three different kinds of mold. How many different kinds of mold spores must have fallen on their bread? Three. Why do you think so? Each kind of mold came from a different kind of spore.



A magnified view of a slime mold. The long stalks rising from the mold are spore cases.

Use a microscope and look at small bits of mold from one of the jars. Draw a picture of what you see. Draw an arrow pointing to one of the spores in your picture.

Plan an experiment to find out if mold needs water to grow. Do this experiment if you can. **Use two pieces of dry bread. Moisten one and leave the other dry. Put in separate jars. Observe daily.**

Plan an experiment to find out if mold that grows on bread will also grow on a piece of fruit. Do this experiment if you can.

Transfer mold spores from bread to a piece of fruit. Cover and observe daily.

4. Part Three Observe Yeast Budding

Yeast is a one-celled plant. It reproduces by pinching off small pieces of its body. These small pieces are called buds and will grow into new yeast plants.

Make a slide from some yeast cells that your teacher has put in sugar and water. Look at the slide under the microscope.

How many yeast cells do you think are on your slide? **Thousands.**

Try to find some yeast cells that are reproducing. Draw two or three of these cells that have one or more small buds on them.

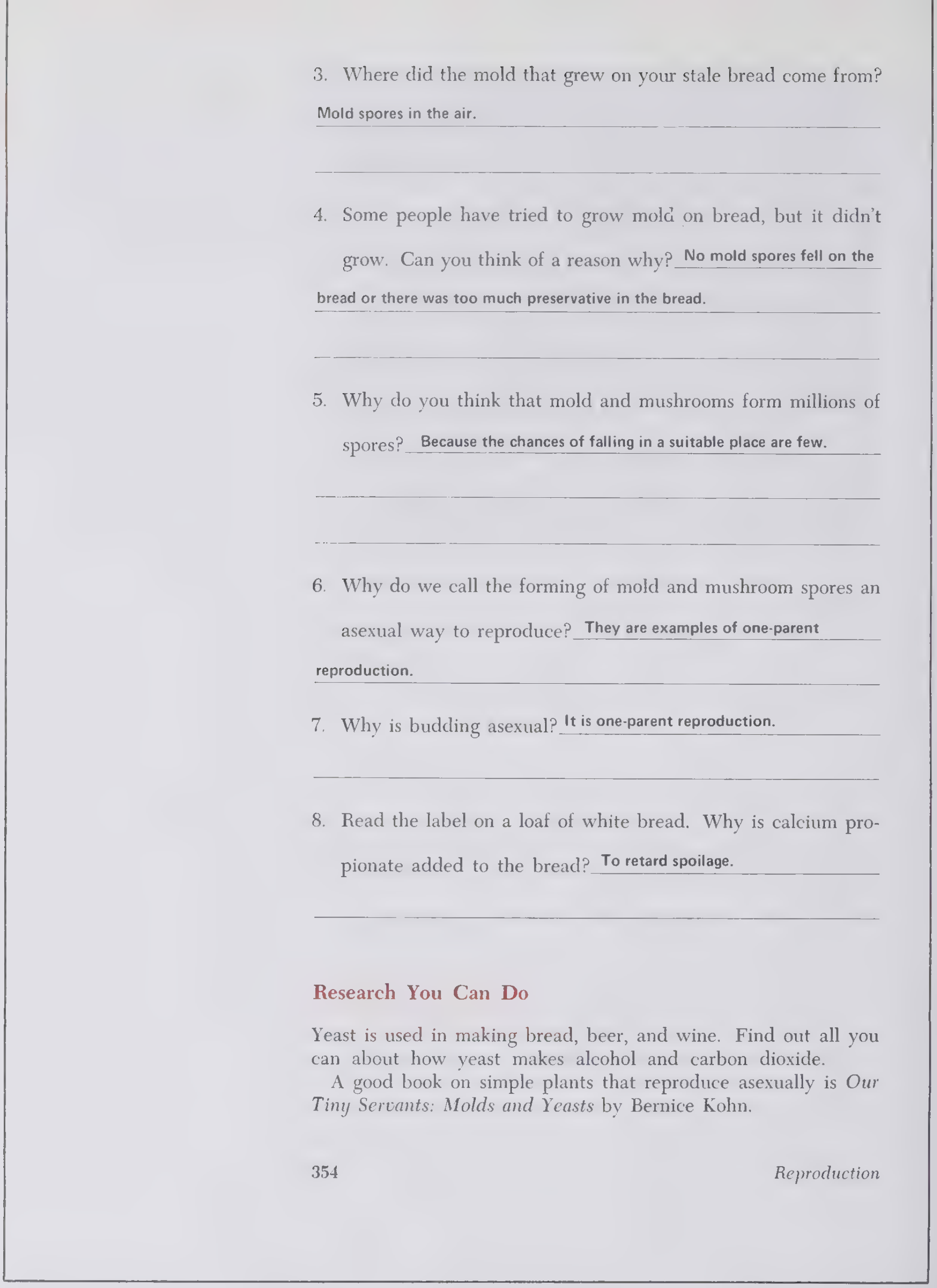
Check Yourself

1. Mushrooms and molds do not contain chloroplasts. So they do not make their own food. Where do you think they get food?

They absorb food from the environment on which they grow.

2. The yeast plant does not contain chloroplasts. Where does the yeast get its food? **From the sugar (or carbohydrates) in their environment.**

4. Part Three Use a small drop of the yeast mixture. A large drop will contain too many yeast cells.



3. Where did the mold that grew on your stale bread come from?
Mold spores in the air.

4. Some people have tried to grow mold on bread, but it didn't grow. Can you think of a reason why? No mold spores fell on the bread or there was too much preservative in the bread.

5. Why do you think that mold and mushrooms form millions of spores? Because the chances of falling in a suitable place are few.

6. Why do we call the forming of mold and mushroom spores an asexual way to reproduce? They are examples of one-parent reproduction.

7. Why is budding asexual? It is one-parent reproduction.

8. Read the label on a loaf of white bread. Why is calcium propionate added to the bread? To retard spoilage.

Research You Can Do

Yeast is used in making bread, beer, and wine. Find out all you can about how yeast makes alcohol and carbon dioxide.

A good book on simple plants that reproduce asexually is *Our Tiny Servants: Molds and Yeasts* by Bernice Kohn.

Exploration 3. Growing Plants Asexually

Overview

A great deal of interest and a competitive spirit can be expected when the class does this activity. They enjoy watching plants grow. Take a minute to explain that one box of sand is to be used by each group as it follows the lab directions and the other box is to be used for Part Four, Your Own Experiment.

Part Four is an activity in planning and doing an experiment. It may be that only the plan can be made the first day and the experiment will be started the second day. Be prepared with an assortment of objects than can be used as flowerpots (milk cartons, cottage cheese containers, coffee cans, for example) because students will want to salvage the plants that were propagated successfully.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) make an hypothesis of asexual growth.

(2) carry out a test of an hypothesis.

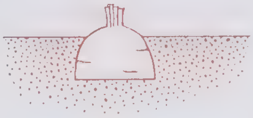
Materials for Each Group

knife
two boxes of damp sand
sweet potatoes
carrots

Exploration

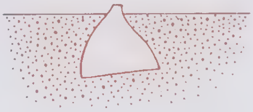
3. Growing Plants Asexually

1. Your job today is to try to grow whole new plants from parts. This time you will use plants that are more complex than molds and mushrooms. Each group will have two boxes of damp sand to use for planting. Use one box for Parts One, Two, and Three. You will use the second box of sand for Part Four.



2. Part One From Part of a Root

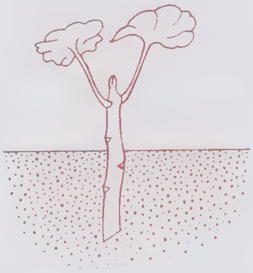
Cut about 3 cm off the top of a carrot and bury this piece in the damp sand with just the top showing.



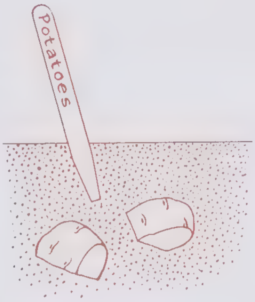
Cut about 5 cm off the top of a sweet potato and bury the piece in the damp sand. Again, leave just the top uncovered as you can see in the drawing.

3. Part Two From Part of a Stem

Cut a piece of stem about 10 cm long from a coleus or geranium. Cut off any leaves that are within 4 cm of the *cut* and stick the stem into the sand.



The white potato is an underground stem. Cut two pieces of potato. Each piece should contain at least one eye. Plant the pieces in the sand about 1 cm deep. Mark the spot with a wooden label so you won't forget where you put them. Follow the drawing on the right.



4. Part Three From a Leaf

What kind of leaf are you using? Varies. ____________

Place the stem of the leaf in the sand. Be sure to press the sand around it.

coleus or geranium
white potato
bryophyllum, African violet, begonia (leaves)
plastic bags (large enough to hold the boxes of sand)
wooden sticks for labels

Time

Three days

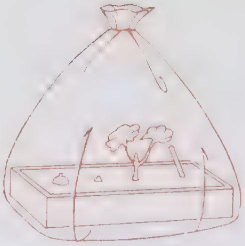
1. This activity will take one period to start but will have to be observed for two or three weeks. During this time the students check their plants every day or two and record data on the chart. Although the plastic bags conserve water, the sand may have to be watered once or twice, and any dead, decaying, or moldy plants will have to be removed.

After a day or two, start "Regeneration in Planaria," and then both experiments will have to be watched.

The planting boxes may be small disposable flats such as a nursery uses, milk cartons with one side cut out, fruit baskets, or empty food containers.

2. Part One Use healthy carrots and be sure that the tops have not been trimmed at the market by cutting into the carrot tissue. The top of the sweet potato is the flattest end. Rarely, sweet potatoes are dipped in a chemical before they are sent to the market. If your sweet potatoes have had this treatment, they may not sprout. A sweet potato may be propped with toothpicks in a jar of water so that half of it is covered. It will sprout into an attractive plant.

3. Part Two Coleus is practically foolproof and quick-growing. Geranium, begonia, tradescantia or aluminum



When you have finished Parts One, Two, and Three, put the planting box into a large plastic bag and tie the top, as shown here. This will make a little greenhouse and keep the sand from drying out. Check your plants at least three times a week. Keep a record of changes you see on the chart on the next page. If there is no change, show this on the chart. When there is a change, describe it in your own words. *Do not dig up any of the plants at this time.*

At the end of three weeks dig up all your plants. Complete the chart on the next page by noting what has been taking place underground. You might then want to put some of your plants into pots of soil and take them home.

5. Part Four Your Own Experiment

Use the other box of sand to do your own experiment. Decide on a hypothesis that you want the experiment to test. You can use one of the following hypotheses. Or you can suggest an idea of your own.

1. Temperature affects the growth of a new plant started from a piece of root, stem, or leaf. How would you test this?

Students plan own experiment.

2. There must be an eye on a piece of potato before it grows into a new plant. How can you test this? **Student observation.**

3. One eye alone (without any potato attached) will grow into a new plant. How can you test this? **Student observation.**

plant can be used with good results. The "eye" of a potato may have to be pointed out to the class.

4. Part Three Leaves of bryophyllum (air plant), or African Violet, or begonia root easily. After the gardening is completed and the planting box is in the plastic bag, keep it where it will get light but not direct sunlight.

5. Part Four This part may carry over to another day. This activity is to plan an experiment based on a hypothesis. Although the suggested questions may be used, encourage originality and be free with praise for those that are using a question of their own. Before this experiment has been completed, there will be days when the plants have been checked and data recorded in ten minutes. What do you do in the other thirty? You may want to start the next Exploration "Replacing Lost Parts." Some time might be used for a film on plant propagation or regeneration.

Reading or rereading "When One Parent Is Enough," will be meaningful after the students have had some experience with the lab work. Use it as a discussion guide by having students read orally and stop at the end of each paragraph.

Plant Part	Date	Above Ground Changes	Underground Changes
Carrot		Students plan own experiment.	
Sweet potato		Students plan own experiment.	
Stem		Students plan own experiment.	

White Potato		Student observations.	
Leaf		Student observations.	

4. A plant stem without any leaves will grow into a new plant.

How can you test this? Answers will vary.

Write your own hypothesis, if you have one you'd like to test:

Answers will vary.

Now write your plan for an experiment to see if your hypothesis is right. Answers will vary.

List the material that you need for the experiment. Answers will vary.

What is the best way to keep a record of what happens? Answers will vary.

Before you start, let the teacher or the rest of the class help you decide if you are planning a good experiment. In other words, will the experiment really test your hypothesis? Now do it.

At the end of this work look at your records. What are the results of your experiment? Answers will vary.

Check Yourself

1. What parts of a plant were missing from the piece of carrot root that you planted? Did these parts grow back? Stem and leaves were missing. Student records information.

→ H 246

2. What parts of a plant were missing from the piece of white potato that you planted? Did these parts grow back? Roots, stem, leaves missing. Student records information.

3. Why do you think a farmer or a florist may use a piece of stem instead of seeds to grow some plants? It is quicker. And the new plant will be identical to the old.

4. Why must seedless grapes and seedless oranges be grown asexually? Because they lack seeds.

Exploration 4. Replacing Lost Parts

Overview

Asexual reproduction in an animal will complete the survey of this topic. Planaria will regenerate noticeably within two or three days and completely in ten days or two weeks. This is an exercise in responsibility because the flatworms must not be allowed to dry out. Keep a supply of water from a pond or aquarium, or aged tap water to be used by the class to replace any water that evaporates. One group will show an interest in another group's worms and how fast they are replacing parts. Encourage each group to share its results.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) define or describe *regeneration.*

(2) name one or more animals than can regenerate.

Materials for Each Group

planarians
scalpel (single-edge razor blade)
petri dishes
pond water
hand lens

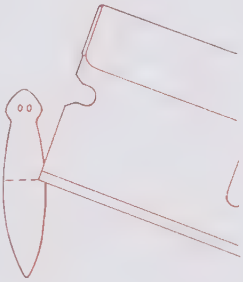
Exploration
4. Replacing Lost Parts

1. **Planarians** (*pluh NAIR ee uhns*) are small flatworms that live in freshwater ponds. If they are broken into two pieces, each piece will grow. It will replace the parts that are missing.

   Today you are going to cut some planarians into pieces and watch for **regeneration** (*rih* JEHN *uh RAY shuhn*). Regeneration means replacing lost parts. Each group will have two or three planarians to work with.

2. **Part One Cut in Two**

Place a planarian in a small dish of pond water. Use a razor blade to cut the worm into two pieces across the middle. You now have a head half and a tail half. Cover the dish and move it to a cool, dark spot.



Time

Two days

1. This activity can be started two days after "Growing Plants Asexually." The change from plant to animal will not cause confusion but will reinforce the idea of asexual reproduction.

If enough flatworms are available, this activity can be done by each student. If there is a limited number of worms, divide the class into groups as small as possible. Less than two weeks may be enough time to show regeneration.

2. Part One Use a quick stroke to cut the worm in two. Keep the worms in water that has been allowed to stand at least overnight. Use petri dishes or any other dish that can be covered.

3. Part Two Cut Your Own Way

Use another planarian and cut it differently. This worm should be in another dish of pond water. Label the dish and move it to a cool, dark spot.

Draw a picture to show how you cut this worm.

Look at both worms three times a week. Use a hand lens. Do not let the dishes dry out. If you need more water, be sure to use pond water or water from a fish tank. The chemicals in tap water may harm the planarians.

Keep a record of any changes that you observe each time you look at the planarians. Regeneration takes about two weeks.

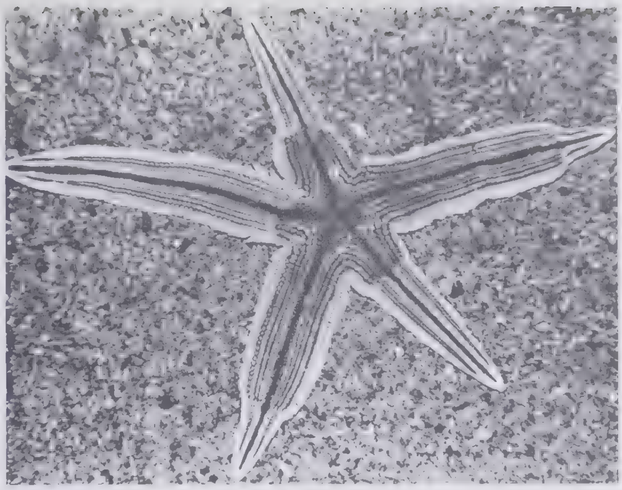
Date	Observations
	Student observations.

There are other animals that can develop new individuals from small pieces of the body. An animal like the sponge can be chopped up into very small pieces. Each piece will grow into a whole animal. In these unusual cases, regeneration is like reproduction.

→ H 247

3. Part Two Let the student decide how to cut the second worm. Usually planaria will survive if cut into as many as four pieces.

If this lab is started two days after Asexual Plants, the data for both labs will have to be recorded. There will be days when some time will be left at the end of the period. Discussion, a film or quiz, a game of password or (as suggested in the last lesson) reading or rereading the text material will fill in the period in a fruitful way.



Starfish can regenerate lost arms. How many arms has this starfish replaced?

Other animals can replace a part of the body that has been lost or destroyed. This is not reproduction, because a new living thing is not made. For example, a crab can grow a new claw.

With complex animals, including man, we find that damaged cells may be replaced, but not a complete part. Your cuts will heal. But you can't grow a new finger or a new foot.

Check Yourself

1. What is regeneration? Replacing lost parts.

2. Is regeneration sometimes an example of asexual reproduction?

Yes, when it results in more individuals.

3. What animals besides planarians can regenerate parts of themselves? Starfish, salamanders, sponges, crabs, lobsters, and some lizards.

4. In what way can people regenerate? They can replace skin, liver tissue, bone, muscle, and many other tissues.

1. MALE AND FEMALE fireflies have lights so they can attract each other in the dark. Many animals attract their mates with their fancy looks — with pretty feathers or clothes, for example. But not starfish. Starfish reproduce without ever seeing the opposite sex. The males pour into the sea millions of sex cells called sperms. The female starfish make millions of sex cells called eggs. Millions of sperms and eggs drift around in the sea and die without joining. But some sperms unite with eggs to produce new starfish.

2. Starfish, fireflies, and people are not like each other in many ways. But they all reproduce sexually. That is, the males produce sperms and the females produce eggs. The joining of one sperm and one egg to produce a new organism is called **fertilization** (*furt l uh ZAY shuhn*). All but the simplest plants and animals reproduce sexually.

3. When an animal lives in the water, it is easy for the sperms to swim to the eggs. Sperms have long tails for swimming. Fertilization takes place in the water.

Animals that live on land have a problem. There is no water to carry their sperms. The males partly solve this problem by making

Reading 5. Sexual Reproduction

1. Millions of sperms are produced for each egg that is formed. This is true of humans, too.
2. Although the sperm is much smaller than the egg, it contains the same amount of DNA.
3. The fluid that the female land animal produces lubricates the path that the sperms will take as they travel inside her body.

a fluid that the sperms can swim in. The male fluid, along with the sperms, is placed inside the body of the female. The females also make a fluid the sperms can swim in. Fertilization takes place in the female. Again, only one sperm can unite with each egg.

The fertilized eggs of turtles, snakes, and birds are enclosed in a shell. They are then laid outside the body, where they will hatch. These are the eggs you are used to calling eggs. They are large. They contain both the developing animal and a food supply (the yolk).

4. The animals that are called mammals carry the new individual inside the body of the female until it is ready to be born. You are a mammal. So is a mouse, a whale, a porpoise, a pig, and an elephant.

Flowering plants reproduce sexually, too. The flower usually contains the male and female organs. (Some plants have separate male and female flowers.) A powdery substance called **pollen** (PAHL *uhn*) behaves like sperm in animals. Pollen is made in the male part of the flower. It fertilizes the egg, in the female part of the flower. The fertilized egg develops into the part of a seed that will grow into a new plant.

Plants, like land animals, have a problem in getting the sperm to the egg. Plants depend on outside help. Brightly colored flowers attract insects and other small animals. When insects visit the flowers to drink the plant juices, pollen sticks to their bodies. The pollen is carried from flower to flower. Wind and water also carry pollen for some flowers.

Finally, some flowers are built so that the eggs can be fertilized by the flower's own pollen.

Living things have many different ways of reproducing. Each way is a success if it replaces the plants or animals that die.

Bumblebees collect pollen for food. Some pollen fertilizes the flowers that the bees visit. You can't collect much more pollen than this bee has got!

4. Guppies and snakes that bring forth living young are *not* placental animals and should not be confused with the live-bearing mammals.

Exploration 6. The Flower

Overview

The idea of viewing the flower as a reproductive structure will be new to most of the students. As the flower is dissected and observed, keep emphasizing its function. Try to get the class to visualize the cycle of flower to fruits and seeds. Some basic biological concepts are built into this activity: the interdependency of plants and animals, the survival value of adaptation to the environment, the complementarity of structure and function, and the "overproduction" of pollen to insure fertilization.

← H 250

Exploration
6. The Flower

Blue-eyed grass grows wild in fields. The blue flowers are the "eyes." Grass on a lawn also flowers if it's not mowed.

1. In this exploration you will study a flower. The flower is the part of a plant that carries on reproduction.

What is the name of your flower? Answers will vary.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) name the reproductive parts of the flower.

(2) describe the function of each part.

Materials for Each Group

flowers
scalpel (single-edge blade)
scrap paper
hand lens (optional)

Time

Two days

1. A simple flower is needed for this lab. Many students have never really looked at a flower. If your source is a florist ask for snapdragons, sweet peas, pansies, gladiolas, daffodils, tulips, or lilies. The latter two are expensive to buy, but he or she may give you flowers that are not fresh. If a neighbor's garden or a park is your source, use the same list plus most flowering shrubs and fruit blossoms. Do not use composite flowers such as dandelions, zinnias, marigolds, or chrysanthemums. They are too complex. If you can, have extra flowers to give away. Some students won't want to tear theirs apart.

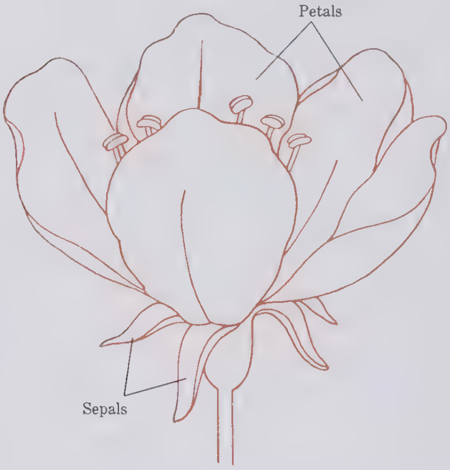
2. Part One Petals

The most colorful parts of a flower are the petals.

How many petals can you count on your flower? Varies.

What color are the petals? Varies.

Carefully remove the petals and place them on a piece of paper.



3. Part Two Sepals

Most flowers have a ring of small green parts outside the ring of petals. They look like leaves. Each one is called a **sepal** (*SEE puhl*). Sepals cover and protect the flower when it is just a bud.

Can you find sepals on your flower? Varies.

Count the sepals. Varies.

Carefully remove the sepals and place them on the piece of paper.

2. **Part One** Try to get a variety of different flowers.
3. **Part Two** In monocots the outer ring of "petals" is really a ring of sepals and is not green.
4. **Part Three** Some student may want to make a slide of pollen grains. In some areas the pollen count is given as part of the weather report in the fall.
5. **Part Four** Some students may need assistance in cutting the ovary.

4. Part Three Stamens

Inside the petals you can find a ring of stalks. These are the **stamens** (*STAY muhns*). They are the male reproductive organs.

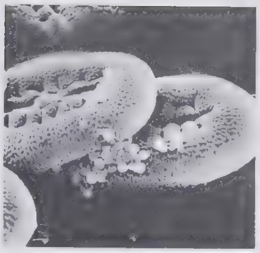
How many stamens do you find? Answers will vary.

What does a stamen look like? It is usually a filament with a larger tip.

The part of the stamen that makes pollen grains is the tip.

Can you find any pollen there? It looks like a powder. Yes.

Carefully remove the stamens and place them on the paper.



Pollen grains from a Central American plant. The little balls on them are dust specks. × 2000

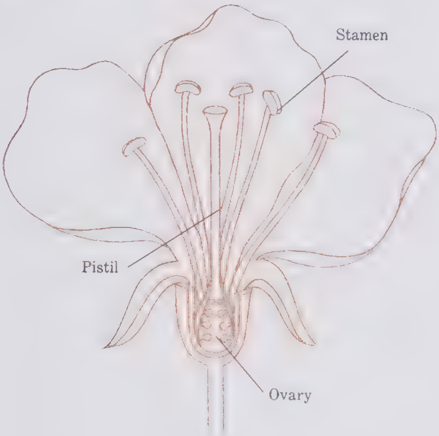
5. Part Four Pistil

The center part that you have left is the female reproductive organ. It is called the **pistil**.

How many pistils are there on your flower? One (by choice of flower).

The lowest and thickest part of the pistil is called the **ovary** (*OH vuh ree*). This is where fertilization takes place.

Cut across the ovary. What do you see? Small seedlike structures.



H 253

The small parts that you see will become seeds. They contain the eggs. About how many of them do you see in the ovary of your flower? Varies.

One pollen grain is needed to fertilize each egg. About how many pollen grains would be needed to fertilize every egg in the ovary of your flower? Same as number of seeds seen in (1).

Check Yourself

1. How do you think bright and colorful petals are helpful to a flower? They attract insects which carry pollen.
2. What is pollen? The male reproductive cell.
3. Can you think of any advantage of having male and female parts on the same flower? Self-pollination is possible.
4. Grass and many trees have small green flowers that you may never have noticed. How does pollen from these flowers get scattered? By the wind.
5. Fertilized eggs in flowers become the seeds you find in fruits. How many eggs would you find if you cut into the ovary of these flowers?

   cherry One.
   tomato Hundreds.
   apple Varies (often 8).
   watermelon Hundreds.
   peach One.
   seedless orange None.

Exploration 7. Development of a Chicken Egg

Overview

Embryology of the chick will provide the class with the background for a survey of human development. This, after all, is their big interest, and wherever possible the subject matter should be handled to reflect the human situation.

The stage of development in each egg will be far enough advanced to show obvious changes when compared with the previous stage. Diagrams or slides can be used in place of eggs, but the lesson will be less exciting.

Behavioral Objective

After completing this Exploration the students will be able to

(1) describe some stages in the development of a chick.

Materials for Each Group

1 5-day chick egg
1 4-day chick egg
1 2-day chick egg
1 unincubated egg
petri dish
hand lens (optional)
scissors with fine points
paper towels

Exploration

7. Development of a Chicken Egg

You have probably never seen a fertilized chicken egg. That's because most hens never mate with a rooster. The eggs you buy at the store are not fertilized.

In this Exploration you will be working with eggs that have been fertilized.

A hen's eggs are fertilized inside her body. Afterward, the hard shell forms around the egg. The egg is laid and takes 21 days to develop and hatch. During this time the hen turns the eggs several times a day and incubates them with her body. The eggs must be warmed for the chick to develop.

1-2. Fertilized chicken eggs have been placed in an incubator in your class. Each group of students will get these eggs:

1 egg that has been incubated for five days

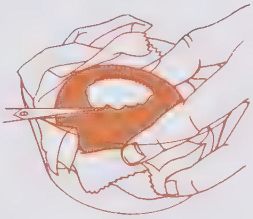
1 egg that has been incubated for four days

1 egg that has been incubated for two days

1 egg that has not been incubated at all

← H 254

Place each egg in a deep dish and mark how long it was in the incubator. Now cut away part of the eggshell. Start by making a small hole with the point of the scissors. Be careful not to jam the scissors all the way into the egg. Then cut carefully. Lift off the top of the shell and look at the developing chick. You may want to use a hand lens.



In which eggs can you see these parts?

1. blood vessels going from the embryo to the yolk Two days.
2. beating heart Two days.
3. eye Two days.
4. head Two days.
5. beginning of leg and wing development Four days.
6. membranes that will cover the embryo Two days but may not be obvious until fourth day.

Time

Two days

Teacher Preparation

Buy the eggs from a chick hatchery or agricultural school to be sure that they are fertile. Eggs from a supermarket are not fertile. Fertile eggs can be kept in the vegetable bin of a refrigerator for a week or ten days after you buy them and before they are incubated. Chilling for this length of time will not affect their ability to hatch.

An incubator should be set at 102°F. Although 103°F. is ideal, setting the thermostat a bit lower is recommended for schools because slightly lower temperature is not critical. But, if it fluctuates upward much over 103°F., development will stop.

Put eggs in the incubator five days, four days, and two days before the lesson. Keep the incubator in the classroom and let the students see you put the eggs in it. Mark each egg to show time of incubation. Some chick hatcheries will incubate eggs for you on order and you can pick them up already incubated for the proper length of time.

1. A crumpled paper towel put in the culture dish will help keep the egg from turning as it is cut.

2. Instead of discarding an egg after examining the developing chick try this activity. Place a cover slip over the opening of the eggshell. Seal the cover slip with paraffin and place the egg in the incubator. Ask students what they think will happen to the embryo. Will it continue to grow? Have students examine the egg each day

Check Yourself

1. Which parts of the body of the chick seem to develop first?

Heart, blood vessels, head, brain, eye.

2. What does the developing chick embryo use for food?

Egg yolk.

3. How does this food get into the embryo? Through blood vessels that go to yolk.

4. What could make the chick hatch out of the egg when 21 days are up? Let students speculate.

Research You Can Do

The man with the geese is Konrad Lorenz. The young geese behave as though he were their mother. Find out why.

and record their observations. In most cases the embryo will not develop because it was exposed to contaminants when the egg was opened. But, there is a slight chance that one egg may hatch.

H 255

Reading
8. Male and Female

1-3. FROGS, BIRDS, and many other animals have special times of the year to mate and have offspring. Mating is an inborn response. And mating and having offspring usually go together.

People don't behave in the same way. They can mate at any time. They can choose whether to mate or not. They may choose not to mate at all, or to mate without having children.

People usually choose their mates because they are attracted to them. What are the kinds of things that people find attractive? Just what is masculine or feminine about someone?

Maybe you think it's manly to have big muscles and a beard or a moustache. Maybe you think boys and men are supposed to be interested in cars or sports. Maybe you think girls and women should not be very muscular. Or do you admire female athletes? Do you think it is feminine to like children, or poetry, or long hair?

Often, people from different countries disagree on the answers to these questions. In Israel, for example, girls do heavy farm work right alongside the boys. They also serve in the army. In some Arab countries men never do heavy work like carrying pails of water. There are always women to do that, they think!

H 256

Reading 8. Male and Female

1. This is a lesson that could lead to a lively and worthwhile discussion. You may want to do a little background reading before you present the lesson to the class.

2. A little attention-getting exercise is to get several pictures of very young babies. Paste pictures of a doll, a car, etc. on different pictures and ask the class to tell whether each child is a boy or a girl. Then ask what helped them make their decisions.

3. This Reading and the next Exploration are quite unstructured and require a lot of planning to make them meaningful. You may want to handle them together as one lesson. The response of the class should be your guide.

There are some physical ways that most males and females differ. Some of these differences develop during **puberty** (*PYOO buhr tee*). Puberty is the time when people's bodies develop the ability to reproduce.

During puberty a girl's shape changes. Her hips usually become wider in respect to her waist, and her breasts get larger. There is also one sudden change — when she begins to **menstruate** (*MEHN stroo ayt*), or have "periods." Menstruation is a sign that the egg cells in a girl's body have begun to develop.

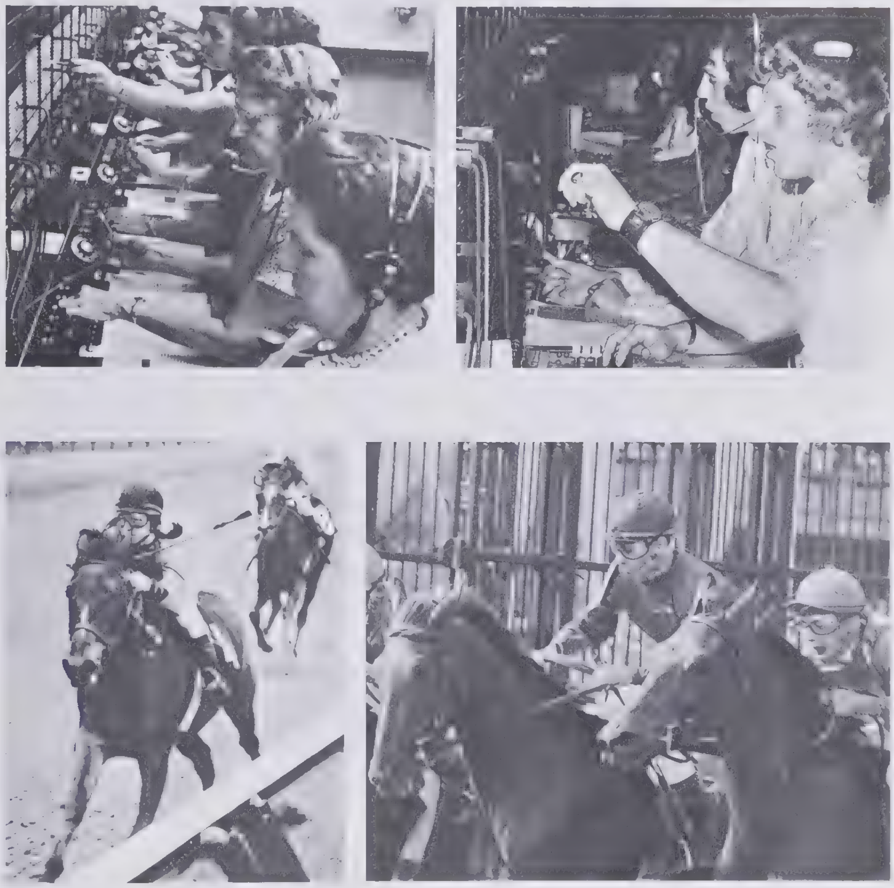
During puberty a boy's voice gets deeper. He may begin to grow whiskers on his upper lip and chin. (American Indians and some other people don't.) Hair grows under his arms and around his genitals. His chest deepens and his shoulders widen. And his **testicles** (*TEHS tih kuhls*) begin to produce sperms.

These changes mark the physical differences between the sexes. The other things that make people seem masculine or feminine are matters of personal likes and dislikes. And lately, people's ideas have been changing.

Rosey Grier, formerly a tough football player for the New York Giants, enjoys needlepoint. Have you ever tried it?

9. What Do You Think About Men and Women?

1. Is ONE SEX better than the other at the same job? If you think so, circle the people who will do a better job in each pair of pictures on this page and the next page.



Exploration 9. What Do You Think About Men and Women?

Overview

The prejudices of society as well as individual prejudices will be bared in the discussion that follows.

Many students will assume that their roles have been set out for them and that there is no deviation from the male-female life styles. Others will realize that new opportunities open up because of changes in attitudes.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) identify sexual stereotyping in themselves and others.

Materials for Each Group

pencils

Time

Two days

1. This might be a good time to bring in pamphlets or pictures that will show career opportunities that are not stereotypes. Let the students do the talking and accept their reactions to the pictures in this lesson.

← H 259

How do your answers compare with your classmates' answers? Varies.

Who are some of your male heroes? Varies.

Who are some of your female heroes? Varies.

Can women study Industrial Arts at your school? Varies. Can men take sewing and cooking? Varies.

How do children learn to be masculine or feminine? Let students speculate. Suggest that our society dictates this.

Are there any jobs that only men should have? Give reasons for your answers. Let students express their ideas.

Which of these statements do you agree with? Varies.

(1) Men should take care of women. ____________________

(2) Women should take care of men. ____________________

(3) Men and women should take care of each other. ________

Give reasons for your answer.

____

____

____

Research You Can Do

Watch ads on television and collect ads from newspapers and magazines. What do the ad writers seem to think is masculine and feminine? Do you agree with their views of men and women?

____

____

____

____

____

Exploration 10. Human Reproduction

Overview

The programmed format of this activity was intended to allow students to set their own pace for learning. If the program is used correctly, each answer is thought out before it is written and then it is checked and possibly corrected immediately.

Human reproduction is the topic that is the most important in your study of sexual reproduction. It is divided into three sections: (1) the parts of the male and female reproductive systems, (2) fertilization and development of a fetus, and (3) menstruation. Only the high points of each topic are included. If you wish, you can elaborate on the subject after this background has been mastered.

Your students probably know many street words referring to sex, but it is important for them to learn the conventional language used by doctors, nurses, etc. This is also one of the goals of these Explorations.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) identify the reproductive organs in a human male and female.

(2) describe the reproductive process in human beings.

Materials for Each Group

pencils
paper

Exploration

10. Human Reproduction

1. This lesson uses a learning program. The program helps you teach yourself. You can decide how fast you want to go.

Use a piece of paper to cover all of the questions except the first one. Then answer the first question. Move the paper down until you see the correct answer on the right side. If you were right, read the next question. If you were not right, study the right answer before you try the next question.

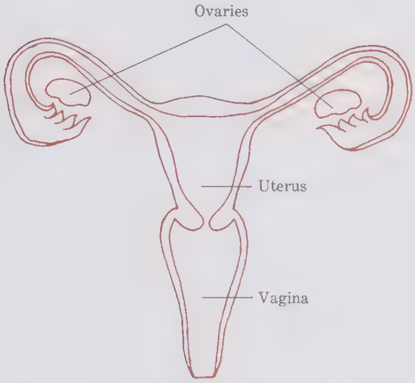
Remember that this program is not a test. You won't get a low grade for wrong answers. So there is no point in just copying the right ones. Try to figure the answers out for yourself.

Hard cover users: To do this Exploration and the next two, direct students to the Laboratory Supplement.

← H 260

Answers

1. Look at the diagram of the female reproductive organs. Eggs are produced by organs called **ovaries** (*OH vuh reez*). How many ovaries are there? Two



2. Ovaries produce the Eggs ______.   *1. two*

Time

Three days

1. A strip of paper the length of the page and wide enough to hide the answer column is used to cover the answers. When the student answers each question, she can check herself immediately by exposing the right answer. If she is wrong, she should check on her error before moving on to the next question. You might want students to write the answers on the same strip of paper.

The other pictures can be used as you see fit. There is at least another day of discussion on the development of the human embryo and the birth of a baby. Bring into the classroom any charts, models and specimens that you have.

In this activity the class discussion can dispel many strange ideas that the students have. For example: Some students think that conception can't occur the first few times that a girl has intercourse.

→ H 261

3. When eggs leave the Ovaries, they pass through tubes to the Uterus.

2. *eggs*

---

4. The **uterus** (*YOO tuhr uhs*) is connected to the outside of the body by a passageway called the Vagina.

3. *ovaries*
uterus

---

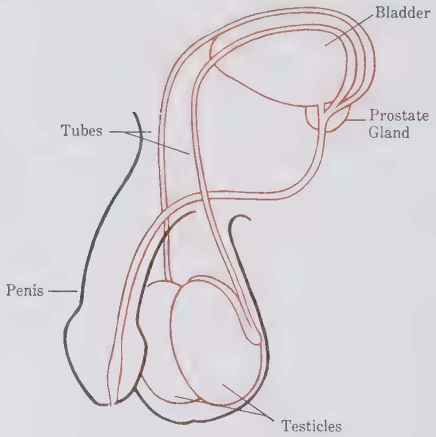
5. Eggs are produced in the Ovaries, move through tubes to the Uterus, and may leave the body through the Vagina.

4. **vagina**
(*vuh JY nuh*)

---

5. *ovaries*
uterus
vagina

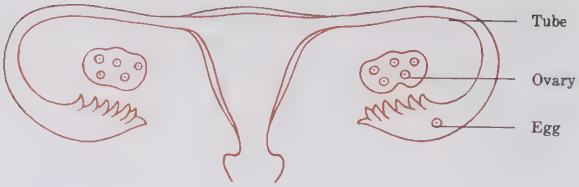
Look at the diagram of the male reproductive organs. The penis is usually soft, except when it is used during mating. In an erect penis the spongy tissue fills with blood and makes it firm.

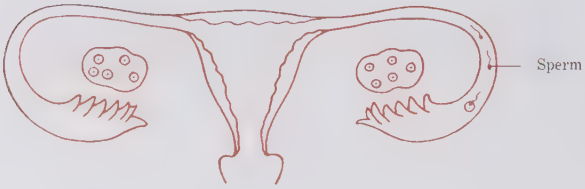


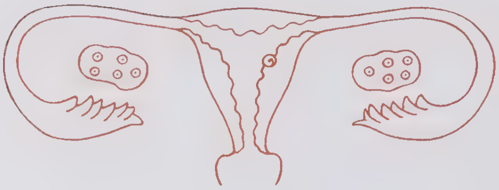
Human sperms. × *900*

6. Sperms are made in organs called the testicles. How many testicles are there? Two	
7. Testicles make millions of Sperms.	*6. two*
8. After the sperms leave the testes, they travel through Tubes.	*7. sperms*
9. Special glands attached to the tubes give off a fluid. The fluid helps the sperms move by Swimming.	*8. tubes*
10. The fluid with the sperms is called **semen** (*SEE muhn*). The organ through which semen leaves the body is the Penis ________.	*9. swimming*
11. The sperms are produced in the Testicles, move through the sperm tube to the Penis, and then leave the body.	*10. penis*
	11. testicles *penis*

← H 262







The diagrams above show how an egg is fertilized and how new life begins.

About once a month an egg leaves one of the ovaries. This is called **ovulation** (*oh vyuh LAY shuhn*). The egg then starts on its journey to the uterus.

---

12. An egg leaves an ovary once every Month.

13. When the egg leaves the ovary, this is called Ovulation.

12. month

← H 263

14. To get ready for a fertilized egg, the wall of the ____Uterus____ thickens.

13. ovulation

15. In order to be fertilized, an egg must unite with a ____Sperm____.

14 uterus

16. The insertion of the male's ____Penis____ into the female's vagina is called **intercourse** (*IHN tuhr kawrs*).

15. sperm

← H 264

17. ____Intercourse____ takes place when the penis is inserted into the vagina of the female.

16. penis

18. Sperms may move from the vagina through the ____Uterus____ and into the ____Tubes____ of the female after being released from the penis.

17. intercourse

19. If an egg is in the tube at the time the sperms are there, the egg may become ____Fertilized____ .

18. uterus
tubes

20. An ____Egg____ may become fertilized any time intercourse takes place.

19. fertilized

21. The first time intercourse takes place, the egg (can, cannot) be fertilized. Can

20. egg

22. An egg can be fertilized by how many sperms? ____One____

21. can

22. one

Check Yourself

Many people have heard a lot of stories about intercourse and reproduction. For example, some people think a woman can't get pregnant from a single act of intercourse. Now might be a good time to check out some ideas you have about reproduction to see if they are true. Ask your teacher or a doctor or go to the library.

Research You Can Do

Explore the views of your community and your state on birth control.

Exploration 11. How a New Person Begins

Overview

This is a continuation of the last lesson and deals with what happens to a fertilized egg. Most students will have no more than a sketchy and fanciful notion of how a new person develops.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) describe some of the stages in the prenatal development of a human being.

Materials for Each Group

pencils
paper

Time

Three days

1. Make use of the illustrations and refer back to the "Development of a Chicken Egg" in this chapter.

2. Consider inviting a doctor or other health expert to talk to the class about this subject. Some states license midwives, who would also make good speakers.

3. Emphasize the importance of prenatal care. Many pregnant young girls delay going to a doctor because of ignorance.

Exploration
11. How A New Person Begins

← H 265

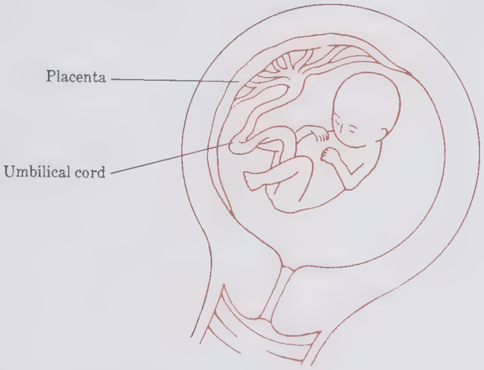
1-2. Cover this page with a sheet of paper. Then move the paper down until only the first question is uncovered. Go through the program at your own speed.

Answers

3-4. 1. A fertilized egg moves into the Uterus___. The uterus has a thick wall with the extra blood vessels needed to feed a growing baby.

2. A special tissue called the **placenta** (*pluh SEHN tuh*) forms in the uterus. The developing baby is attached to it by a cord called the Umbilical cord. It is shown in the diagram below.

1. uterus



3. The **umbilical** (*uhm BIHL ih kuhl*) **cord** connects the Baby___ to the Placenta___.

2. umbilical cord

← H 266

4. You may want to mention that the babies of addict mothers are born addicted.

4. The placenta has a lot of blood vessels. In the placenta, food and oxygen pass from the capillaries of the mother into the capillaries of the developing baby. The blood in the ____Umbilical cord____ carries the food and oxygen to the baby.	3. *baby, placenta*
5. 5. If a mother is not well nourished, you (would, would not) expect her baby to be well nourished. Would not	4. *umbilical cord*
6. Wastes from the baby can pass through the ____Umbilical cord____, to the ____Placenta____, and then to the mother's blood.	5. *would not*

→ H 267

Note. Page 268 corresponds to soft cover page 388.

8 weeks

12 weeks

20 weeks

Mother can feel baby move

Baby can survive if born this early

30 weeks

Just before normal labor

38 weeks

5. Stress the importance of maintaining good health for mother and baby by eating nourishing foods, exercising and avoiding harmful drugs such as tobacco.

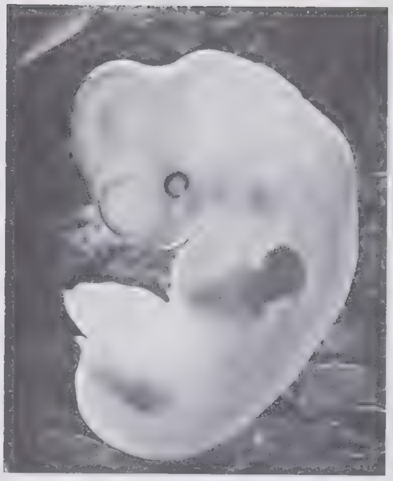
7. After the baby is born, the placenta leaves the mother's body. It is then called the **afterbirth.** It (can, cannot) be used again. Cannot	6. *umbilical cord, placenta*
8. Look at the diagrams of a developing baby. In what week does it begin to move? 20th week	7. *cannot*
9. When does the baby begin to look like a person? 8th week	8. *20th*
10. From fertilization of the egg to birth usually takes 38 weeks. This period is called time of pregnancy.	9. *8th*
11. When a baby is ready to be born, the uterus begins a series of contractions. These contractions are called **labor.** Labor takes place at the end of the time of Pregnancy.	10. *38*
12. Contractions of the uterus are called Labor. They push the baby out of the uterus, through the vagina, and into the World.	11. *pregnancy*
	12. *labor, world*

Research You Can Do

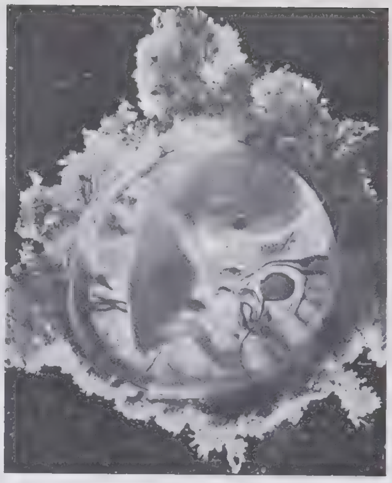
Find out what special care pregnant women need. What activities can they do? What activities should they not do? What special foods do pregnant women need?

What can fathers do to help the mother and baby during pregnancy? And is there anything fathers can do to help while the baby is being born?

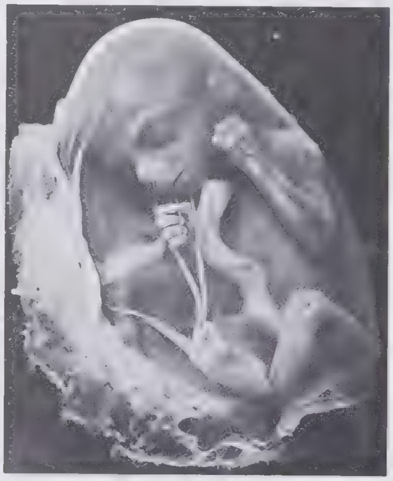
← H 269



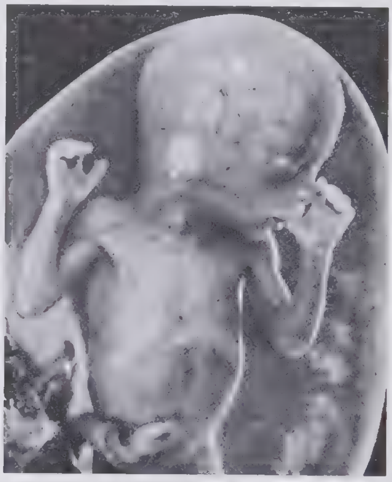
The developing baby at five weeks of age. What parts can you see?



The developing baby at 11 weeks, floating in the watery sack that protects it.



At 16 weeks. Notice the umbilical cord and the blood vessels.



At 18 weeks the developing baby can kick, punch, and suck its thumb.

Exploration 12. The Menstrual Cycle

Overview

The same format ties this activity with the previous ones. This one deals with the question: What happens if the egg is not fertilized? Most students know menstruation as a monthly cycle, but they often have a lot of misinformation.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) describe the stages in the female menstrual cycle.

Materials for Each Group

pencils
paper

Time

Two days

1. If the class can handle it, you may want to indicate that hormones act as chemical messengers and control stages in the menstrual cycle.

2. Some girls have the idea that the "safe" period is in the middle of the menstrual cycle. Point out that the opposite is true!

1-3. Part One Menstruation

1. Each month the uterus prepares for a fertilized Egg .	*Answers*
2. The wall of the Uterus begins to thicken. Extra tissues and blood vessels build up.	*1. egg*
3. Often the egg is not fertilized. The extra tissues and Blood vessels are no longer needed.	*2. uterus*
4. The extra tissues, the blood, and the unfertilized egg pass out of the body through the Vagina .	*3. blood vessels*
5. This flow is called **menstruation**. It usually takes place once a Month .	*4. vagina*
6. Menstruation takes place only if the Egg has not been fertilized.	*5. month*
7. If the egg has been fertilized, the extra tissues and blood vessels will be needed by the developing baby. Menstruation will not take place.	*6. egg*

← H 270

3. Some time should be spent on "Research You Can Do." It is a chance to sort fact from fiction.

Hard cover users: To reproduce the chart for this Exploration please turn to page T 65 or direct students to the Laboratory Supplement.

8. If menstruation does not take place, it is usually a sign of Pregnancy.

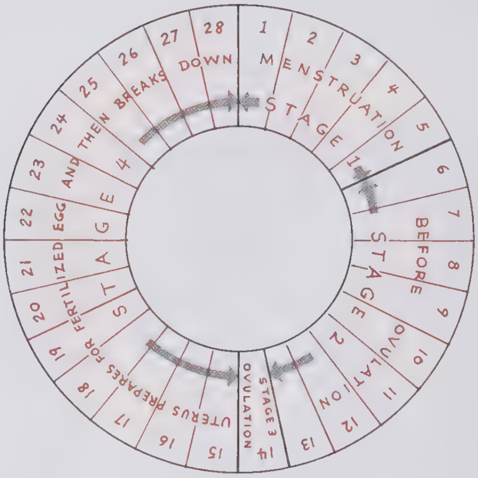
7. menstruation

9. Until an egg is fertilized, the same events happen every Month. These events make up the menstrual cycle.

8. pregnancy

9. month

Part Two On the Average



This chart shows an average menstrual cycle. An average cycle is about 28 days. But many women do not have a 28 day cycle. They can have 24 day cycles or even 35 day cycles. Often young women have an irregular cycle — one that is not the same length each time. Menstruation itself can last from one to seven days.

Color the chart to show the days in which stage 1 usually takes place. What is happening to the uterus during stage 1? Menstrual flow. Extra blood and tissues leave the uterus.

Color the chart to show the days in which stage 2 usually takes place. What is happening to the uterus during stage 2? The wall of the uterus begins to thicken.

H 271

Ovulation takes place on or about day 14. This is the time when the egg leaves the ovary. This is also the time when fertilization can take place. On the chart, put a circle around the day that the egg usually leaves the ovary.

Ovulation can happen at other times in the cycle. You can't always count on it happening right in the middle.

Color the chart to show the days in which stage 4 usually takes place. What is happening to the uterus during stage 4? The wall of the uterus continues to get ready for a fertilized egg.

Use this calendar to fill in a menstrual cycle that a woman might have. Begin on any day in the first month. Then color in each stage and label it.

H 272

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

Hard cover users: To reproduce the calendar for this Exploration please turn to page T 65 or direct students to the Laboratory Supplement.

Research You Can Do

Some women have painful cramps during menstruation. Try to find out what causes menstrual cramps and what can be done to relieve them.

There are a lot of myths about menstruation. For instance, "Women shouldn't bathe when they have their periods." Do you know any other stories about menstruation? Find out if they make sense, or are myths.

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 47 or direct students to the Laboratory Supplement.

Part One

1	~~F~~	~~L~~	~~O~~	D	~~W~~	~~E~~	~~R~~	N	~~S~~	~~P~~	~~E~~	~~R~~	~~M~~	A	~~S~~
2	~~E~~	~~G~~	C	~~G~~	~~S~~	A	R	~~R~~	R	I	~~O~~	E	~~R~~	~~E~~	S
3	H	~~O~~	E	R	~~V~~	~~A~~	E	~~R~~	D	I	T	~~Y~~	A	R	Y
4	C	H	A	R	A	C	T	E	R	I	S	T	I	C	S
5	~~A~~	F	~~S~~	~~E~~	~~X~~	~~U~~	R	~~A~~	~~L~~	O	~~B~~	~~E~~	~~E~~	M	~~S~~
6	~~S~~	~~W~~	~~I~~	~~M~~	O	N	~~M~~	~~I~~	~~N~~	~~G~~	~~W~~	~~A~~	E	~~R~~	~~M~~
7	~~P~~	G	E	~~E~~	~~T~~	N	E	~~A~~	R	~~L~~	A	T	I	O	N
8	~~F~~	~~E~~	~~R~~	~~T~~	T	~~I~~	O	~~L~~	~~I~~	~~Z~~	~~A~~	~~T~~	~~I~~	~~O~~	~~N~~
9	A	N	O	T	~~B~~	H	E	R	~~L~~	~~O~~	~~O~~	O	~~D~~	N	E
10	~~U~~	~~P~~	~~S~~	~~T~~	~~R~~	~~E~~	~~A~~	~~M~~	~~M~~	~~A~~	~~M~~	~~M~~	~~A~~	~~L~~	~~S~~

Answers to the questions are hidden in the puzzle. In each row cross out the letters of the words that answer each question. In some rows there are two answers.

For example, the first answer is FLOWER. So the letters in FLOWER have been crossed out.

Row 1 — Part of the plant that reproduces
1 — Male reproductive cells
2 — Female cell produced by the ovary
2 — Reproductive cell produced by mushrooms
3 — Female organ that forms eggs
5 — Insects that carry pollen
5 — Reproduction by one parent
6 — Sperms move this way
6 — Eggs are put in incubation to keep them__________
7 — Colorful part of a flower
8 — Process of a sperm uniting with an egg
9 — Carries food from egg yolk to the developing chick
10 — Where the salmon goes to reproduce
10 — Animals that carry young inside the body, for example — YOU

The letters that were *not* crossed out in each row form a word. All the words make a sentence. Write the sentence here.

DNA CARRIES HEREDITARY CHARACTERISTICS FROM ONE GENERATION TO ANOTHER ONE.

Vagina	Female (both).
Penis	Male.
Unfertilized Egg	Female (nonpregnant).
Placenta	Female (pregnant).
Sperm	Male.
Ovulation	Female (nonpregnant).
Ovary	Female (both).
Testicles	Male.
Umbilical Cord	Female (pregnant).
Uterus	Female (both).
Menstruation	Female (nonpregnant).
Egg Tube	Female (both).
Sperm Tube	Male.
Fertilized Egg	Female (pregnant).
Semen	Male.

Part Two

Cut out the Reproduction Review cards on this page. Each card has a word that you have studied.

1. Now sort the cards into two piles. One pile should contain the words that belong to the male reproductive system. The other pile will contain the words that belong to the female reproductive system.

   How many words do you have in your MALE pile? Five.

   How many words do you have in your FEMALE pile? Ten.

2. Take the cards that you have placed in the FEMALE pile. Now sort these cards into three piles.

   Pile A will contain the words that belong only with a PREGNANT FEMALE.

   Pile B will contain the words that belong only with a NONPREGNANT FEMALE.

   Pile C will contain the words that belong to PREGNANT and NONPREGNANT FEMALES.

   How many words do you have in Pile A? Three.

   How many words do you have in Pile B? Three.

   How many words do you have in Pile C? Four.

3. What other words can you add to your cards? Let students speculate.

4. Some high school students have thought of other ways to sort these cards. Can you think of any? If so, write them here. Students speculate.

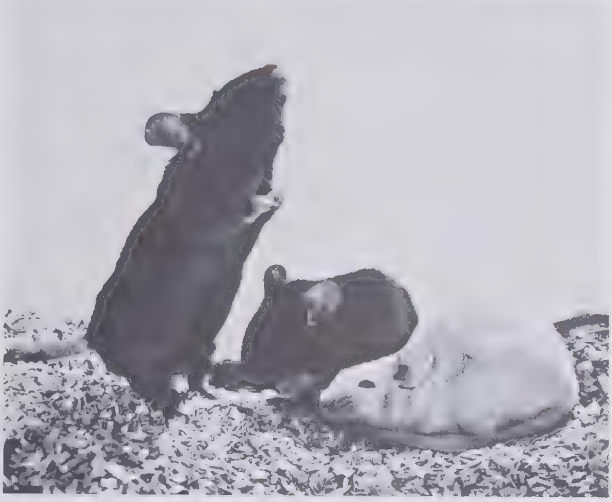
13 Genetics

H 273

H 274

Hard Cover Folios Preceded by H

Reading
1. Why Are You You?



1. The brown mice in the photo are the parents of the white one. You know that offspring are not exact copies of their parents. You aren't exactly like your mother or father. You do have some traits or characteristics you inherited from each parent. But where could the white mouse have gotten its coat?

2. It turns out that some traits are **dominant** (*DAHM uh nuhnt*). They always appear when they are inherited. Other traits are **recessive** (*ree SEHS ihv*). When they are inherited, they can be hidden by the dominant trait.

Brown hair in mice is a dominant trait. White hair is a recessive trait. If a mouse inherits the brown trait from both parents, it will be brown. If it inherits the brown hair trait from one parent and the white hair trait from the other, it will still be brown. But the trait for white hair is not lost. It is just hidden. It can be passed on to the next generation. A mouse will only be white if it inherits the trait for white hair from both parents. The study of inherited traits is called **genetics** (*juh NEHT ihks*).

Reading 1. Why Are You You?

1. This Reading may appear oversimplified. We like to point out that no organism inherits characteristics but rather the ability (the heredity factors) for producing a given trait.

2. What an organism becomes depends not only on the DNA it inherits, but also on its environment. People may inherit the DNA for strong healthy bodies, but babies that are starving will never be able to make full use of this potential.

How a living thing develops depends on its inheritance. But development also depends on the environment. A green plant inherits the ability to make its own food. But it can't use this ability if it is always kept in the dark. People inherit the ability to make red blood cells. But they can't make enough red blood cells if they don't have enough iron in their diets.

Is the ability to paint or the ability to throw a good pass inherited? Scientists do not know the answer. They do know that the traits people inherit set certain limits on what they can become.

But people are better than any other living things at stretching the limits. They use their intelligence and imagination to correct some inherited traits. For example, someone who is nearsighted can wear glasses.

What traits seem to be inherited in this family?

Exploration 2. What Have You Inherited?

Overview

The class will concentrate on two of the few traits in humans that can be studied easily. Work toward understanding the meaning of the terms dominant and recessive, and do not be concerned with Mendelian laws. Instead, emphasize that a recessive trait can appear in an individual who inherits it from both sides of the family. Obviously, whether or not one can roll his tongue or taste PTC paper has no survival value, but they are traits that are fun to consider.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) name two hereditary traits in human beings.

Materials for Each Group

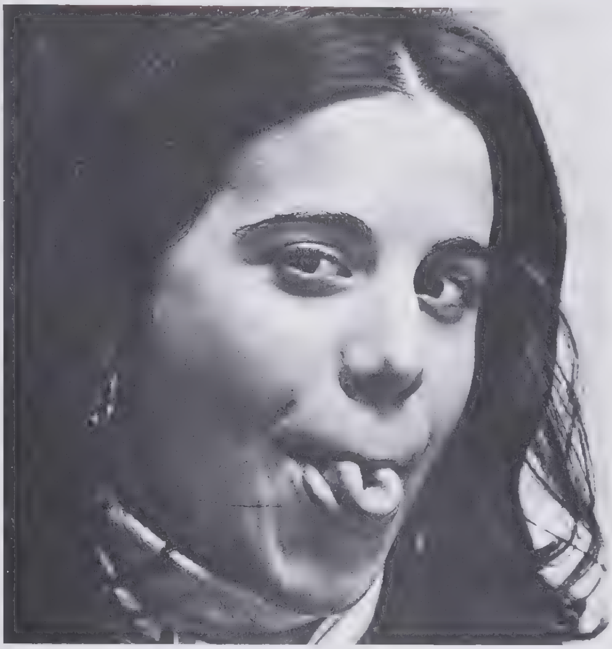
PTC paper

Time

Two days

Exploration

2. What Have You Inherited?



Can you do this?

1. Today you will find out something about your own inheritance. You will study two human traits that are passed from generation to generation.

2. **Part One Tongue-rolling**

Some people can roll their tongues. Rolling the tongue is a dominant trait. Not being able to roll the tongue is a recessive trait.

Can you roll your tongue? Answers will vary.

Count the number of students in the class. Answers will vary.

1. These are two of the few traits in humans that can be studied easily. This activity will reinforce the understanding of dominant and recessive traits.
2. **Part One** You may need to work with students in finding percentages. Changing a decimal to a percent will not be easy for most students.

Count the number of students that can roll their tongues. Varies.

What percent of the class are tongue rollers? Varies.

To find the percent, divide the number of tongue rollers by the number of students in the class. Your answer is a decimal. Multiply by 100 to change your answer to a percent.

Can you tell whether the tongue rollers are carrying the recessive trait? No.

Can you tell whether the nonrollers are carrying the dominant trait? How can you tell? Yes. If you are a nonroller, you must have two recessive traits, i.e., no dominant trait.

Part Two Tasting

You will be given some paper that has been dipped in a chemical called PTC. This chemical can't hurt you. Being able to taste PTC is a dominant trait. Not being able to taste PTC is a recessive trait.

Put a piece of PTC paper on your tongue. Can you taste it? Varies.

How many students in the class can taste PTC paper? Varies.

How many students can't taste the PTC? Varies.

What percent of the class are tasters of this chemical? Varies.

Check Yourself

1. Suppose a person inherited the ability to roll the tongue from one parent and the nonrolling trait from the other parent. Would he or she be able to roll the tongue? Yes.
2. Suppose a person inherited the ability to taste PTC from one parent but not from the other parent. Would that person be able to taste PTC? Yes.

3. Part Two PTC paper may have a different taste to different tasters. Usually it is bitter, but other taste sensations have been recorded. The usual strip of PTC paper can be cut into two or three smaller pieces. This economy measure may give you enough paper to send home with students who want to test members of their family. Keep this part of the activity optional.

3. How much of your nature do you think is inherited? How much depends on your environment? Let student speculate.

4. Do you have abilities you aren't allowed to develop? How could you develop them? Let student speculate.

Research You Can Do

Test your family for PTC tasters and tongue rollers. Include as many relatives as you can. Fill in this chart.

Relative	Tongue Roller	Non-roller	PTC Taster	Non-taster
		Student records information.		

← H 279

Can you tell if any PTC tasters are carrying the recessive trait?

Yes. If one parent is a non-taster.

Can you tell if any tongue rollers are carrying the recessive trait?

Yes. Same as above.

Research You Can Do

A monk who lived in a small country in Europe over 100 years ago was the first person to learn how traits are passed on. He knew less biology than you do. His name was Gregor Mendel. Find out all you can about him.

Exploration 3. We Come in All Sizes

Overview

Besides encouraging an awareness of continuous variation among living things, this activity reviews the metric system and uses graphing that requires classifying numbers into groups. A mathematical idea, the median, is used for the first time.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) construct a bar graph.
(2) show variations in heights on a bar graph.

Materials for Each Group

meter sticks
chalk

Time

Two days

1. Besides teaching awareness of normal variation among living things, this lesson uses a graph as a means of recording information and introduces the idea of a median. The students may have some experience with a median in standardized testing. This same lesson can be done by using a scale calibrated in kilograms and recording the weight of class members as data. If there is

Exploration
3. We Come in All Sizes

1. There are times when we can't call a trait dominant or recessive. Two traits may blend or mix together in the offspring. When this happens, a red flower crossed with a white flower will produce pink offspring.

   There are many human traits that act in the same way. The one you will study today is height.

   Measure the height of each person in your group. Mark the heights with chalk on a wall or on the chalkboard. Then use a meter stick to measure each height in centimeters.

2. Record the height of each person in your group to the nearest

   centimeter. Varies.

   How many students are in the class? Varies.

← H 280

an extremely overweight youngster in the class, stick to the heights. If the class has an even number of students, include your height in the data. With an odd number, the median will be the height of someone in the room. Clarify "to the nearest centimeter."

2. One way of recording heights is to have one student from each group put the data for his group on the board. The class can copy the list from the board. Be sure to list heights separately, even if they are duplicates.

It helps to inherit tallness. What else do you need to become a top athlete? Do you inherit these traits or learn them?

Make a list of all the heights in the class. Be sure to include your own group. Varies.

Now list the heights again. This time put them in order, starting with the shortest and ending with the tallest. Varies.

What is the height of the tallest student? Varies.

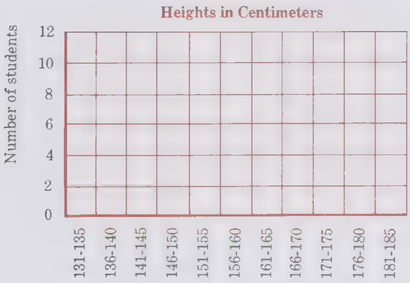
What is the height of the shortest student? Varies.

How would you find the average height for the class? Add the heights of all the students in class and divide by the number of students in class.

Sometimes it is easier to work with a group of measurements if you put them in a graph. First use your list of heights to fill in this chart. Count the number of students that are between 131 and 135 centimeters tall. Put this number in the first space. Use the same method to fill in the rest of the chart.

Centimeters	Number of Students
131–135	
136–140	Class heights will vary.
141–145	
146–150	
151–155	
156–160	
161–165	
166–170	
171–175	
176–180	
181–185	

Now you can use the chart to make a bar graph. Suppose two students in your class had a height between 131 and 135 centimeters. Then you would color in the box in the lower left corner. Use the numbers on your chart to make a bar graph.



Hard cover users: To reproduce the graph for this Exploration please turn to page T 65 or direct students to the Laboratory Supplement.

Check Yourself

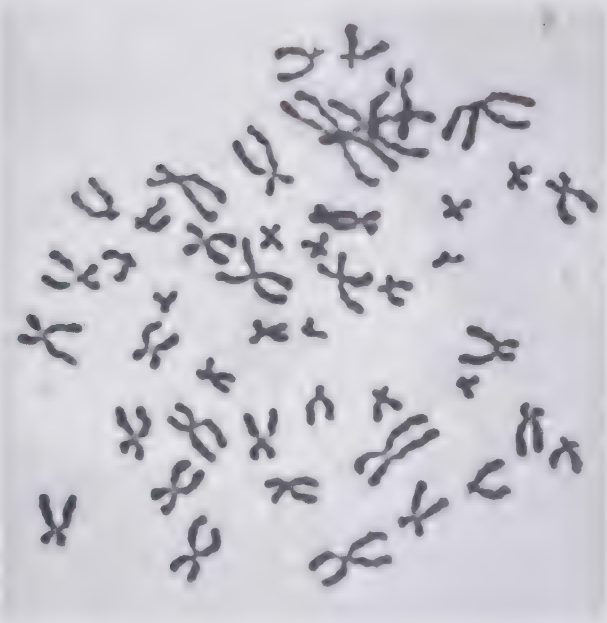
1. How could the environment affect a person's height? Eating proper foods, getting medical check ups ,and doing enough physical exercise would help a person to make the most of his or her inheritance.

2. Were most of the people in your class near the short end of the graph, the tall end, or near the middle? Varies.

3. List some of the ways that the students in your class differ. Tell if you think these differences are due to heredity, the environment, or both. Let students decide.

Reading

4. Plans for Building People



A set of chromosomes like these acts as a brain for every cell in your body. The chromosomes direct the activities of each cell by telling it what kinds of protein to make. × 1000

1. How does a person who builds a house know where to put the doors and windows? How does he know where to put the pipes and electric wires? Before he can begin he needs a plan. The plan tells exactly where to put each part of the house.

Living things also need a plan. It is found in the nucleus of each cell. Giant molecules called DNA carry the plan. The DNA is contained in strands called **chromosomes** (*KROH muh sohmz*).

Each kind of living thing has its own number of chromosomes. A radish has 18, a fruit fly has 8, and you have 46. The chromosomes usually come in pairs. So a radish has 9 pairs, a fruit fly has 4 pairs, and people have 23 pairs of chromosomes.

Each human egg and sperm cell has only 23 chromosomes. When a sperm cell joins an egg cell, the fertilized egg has 46

← H 283

Reading 4. Plans for Building People

1. This Reading sums up some of the information that we've had before. Knowledge of DNA and chromosomes is reinforced, including the fact that half of the DNA comes from the sperm and half from the egg.

chromosomes. In this way, the child gets half its DNA or half its inheritance from each parent.

One pair of chromosomes decides the sex of a child. These chromosomes are called X and Y. When the egg is fertilized, if the child gets two X chromosomes, it will be a girl. If it gets one X and one Y chromosome, it will be a boy. Egg cells always carry an X chromosome. Sperm cells carry either an X or a Y chromosome. That means that the sex of the baby depends on the father.

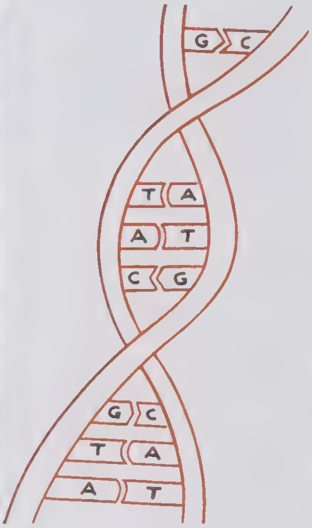
2. The people who studied DNA used their imaginations and the facts they had collected to build a model. Their model of the DNA molecule looks like a twisted ladder. The sides of the ladder are made from molecules of sugar and phosphate. The rungs of the ladder are made from molecules of adenine (A), thymine (T), cytosine (C), and guanine (G). You do not have to remember these four names. Just use the initials A, T, C, and G.

H 284

Each rung of the ladder is made from two molecules joined loosely together. Because of the shapes of the molecules, a C can be joined only to a G. An A can only be joined to a T.

The rungs can be placed on the ladder in any order. That's the trick. There are so many different ways to arrange the rungs, 3. that no two people in the world have the same DNA ladders—except for identical twins. Each person is one of a kind.

A model of a piece of DNA and a photo of the real thing, magnified about four million times.



2. Model-making is one way that a scientist works out his ideas. The students will make a model in the next Exploration.

3. DNA for each individual is unique.

Exploration 5. Build Your Own DNA Ladder

Overview

In this activity the student makes a model of the DNA molecule. The objective is to show that scientists often learn by model-making. The students will realize that the arrangement of the DNA nucleotides seems to contain the biological code, and they will learn the mechanism for DNA replication.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) construct a model of a DNA molecule.

Exploration
5. Build Your Own DNA Ladder

1. Get strips of colored paper and tape. The red paper stands for molecules of A. The blue paper stands for molecules of T. The yellow paper stands for C. And the green stands for G.

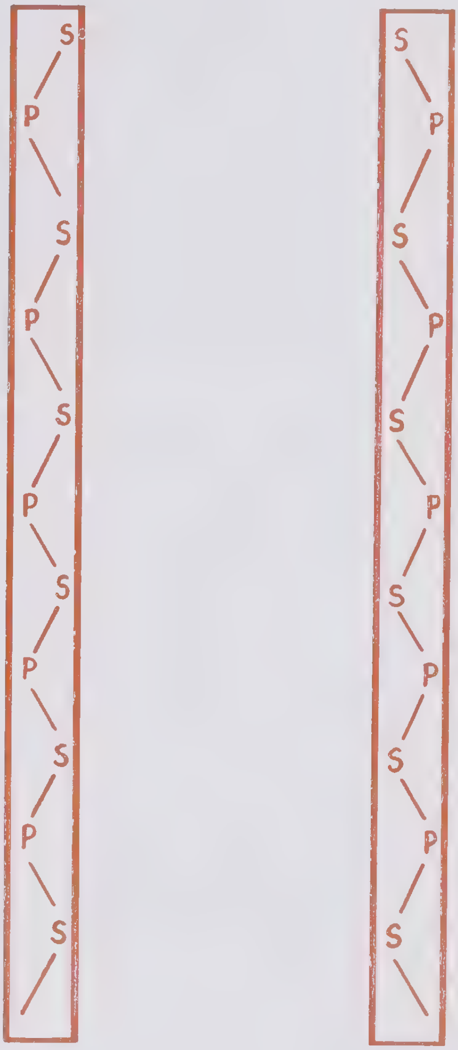
2. **Part One Putting in the Rungs**

You need three pieces of each kind of colored paper for the rungs. The sides of the ladder are printed on this page. S stands for a sugar molecule, P for a phosphate group.
Start with the left side of the ladder. You will make the left side read from top to bottom:

A
T
T
C
G
G

Check off these steps as you complete them.

( ) 1. Place an A molecule (strip of red paper) next to the first S (sugar) molecule.
( ) 2. Pick out the color that stands for a T molecule. Place it below the A and next to the second S molecule.
( ) 3. Use your other pieces of paper to complete the left side of this piece of DNA.
( ) 4. Finish the piece by building the right side of each rung. Remember that A can only pair with T, and C can only pair with G.



Hard cover users: To reproduce the illustration for this Exploration please turn to page T 66 or direct students to the Laboratory Supplement.

Materials for Each Group

strips of red, blue, yellow, green construction paper (18 mm by 8 mm)
cellophane tape (several rolls)
scissors
petri dishes (5-10)

Time

Three days

1. Keep an eye on newspapers and magazines for articles about the biological code, genetic counseling, inherited diseases or anything else that is pertinent. Point them out to the class and encourage an awareness of this kind of news. Sickle cell anemia, hemophilia, Cooley's anemia, Tay-Sachs disease, color blindness, albinism and polydactylism can be presented as changes in the DNA code and, therefore, inherited.

2. Part One The correct size slips of paper can be made by cutting strips 18 mm wide and then cutting across every 8 mm. If you wish, have the class make the left side of the model by working on it together. Then let individual students complete it by working at their own pace.

3. Part Two Split It and Double It

When a cell divides, what does it do with its DNA? It could give half its DNA to one new cell and half to the other. But each new cell would then have only half the information it needed to stay alive. So before the first cell divides, it makes a copy of its DNA. That way each new cell gets a complete set of chromosomes. And copies of DNA can be passed from generation to generation.

The DNA makes a copy of itself by splitting in half lengthwise. Let us imagine the DNA molecule you just made is going to split apart. The rungs of the ladder will break apart. The A's will separate from the T's and the C's from the G's. The sides of the ladder you just made are on the next page. Take your colored strips and put them on each half of the ladder where they belong.

Use more strips of construction paper to build in the missing half of each rung. Tape these parts down. Then draw in the missing sugar (S) and phosphate (P) molecules. That completes the sides of the ladders.

Look at the two new pieces of DNA. Are they exactly alike?

Yes.

Check Yourself

1. Where do you think the cells get the S, P, A, T, G, and C molecules to build new DNA? From materials in the cell and from the food you eat.
2. What would happen if the new DNA were not exactly like the old DNA? Let students speculate. The message or information would be changed. The new DNA would be carrying a different code.

Research You Can Do

Here are two books on human heredity you might like to read: *All About Heredity* by Judith Randal and *Why You Are You* by Amram Scheinfeld.

3. Part Two Be sure to keep the left half on the left side.

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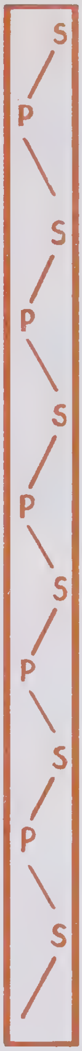
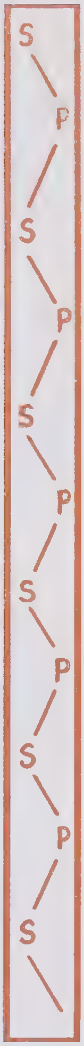
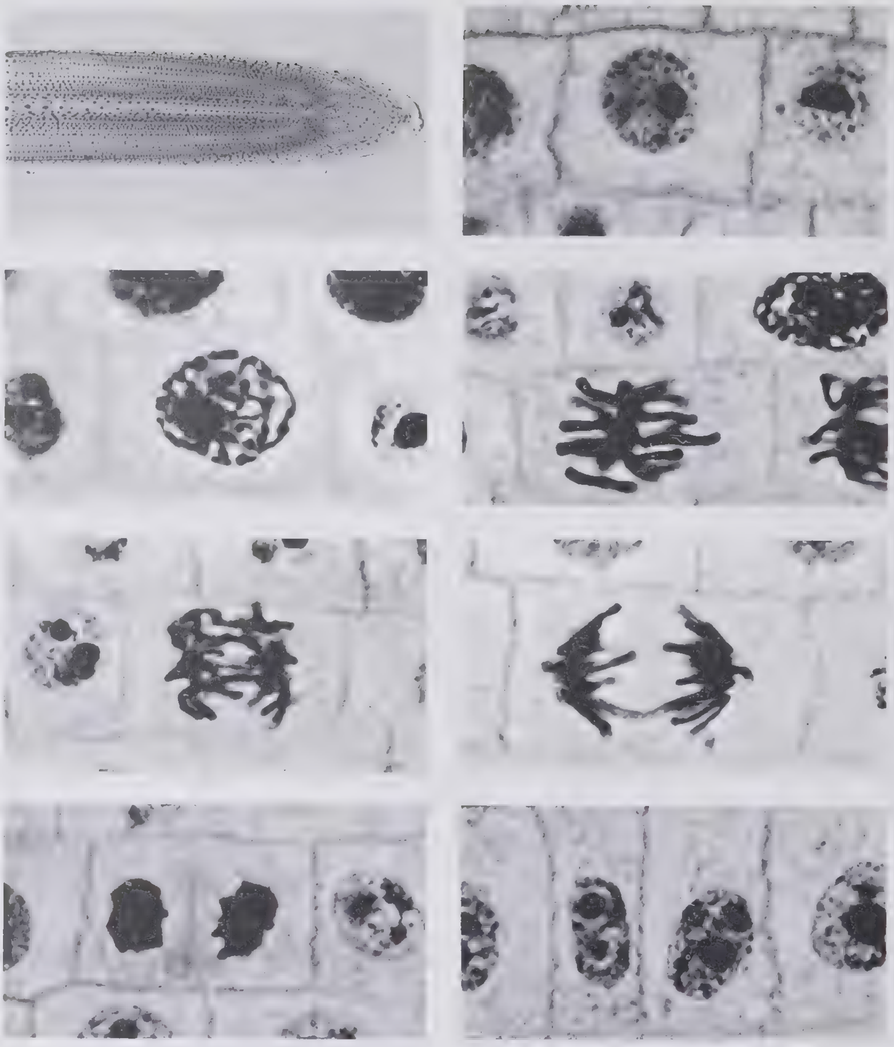






Photos courtesy of the Carolina Biological Supply Company

A good place to watch cells divide is an onion root. Just before a cell divides, the chromosomes become easy to see. At this point, the DNA copies have been made. The chromosomes line up in the middle of the cell and then divide. Soon a cell wall and membrane form in the middle of the old cell. Presto! Two cells.

Reading
6. The Living Code

If you know the code, you can read this message from a very old Egyptian tomb. The message is from the tomb's owner. He promises to curse the people who built his fancy tomb if they try to sneak in any extra dead bodies.

DNA carries messages written in code. You probably know of many different types of codes. Spies in spy movies love codes. People have also used smoke signals or drum beats to send messages.

1. Samuel Morse invented a code that used dots and dashes to stand for letters of the alphabet. Make up a short message in Morse code for a person sitting next to you.

Morse Code

A	•–	S	•••
B	–•••	T	–
C	–•–•	U	••–
D	–••	V	•••–
E	•	W	•––
F	••–•	X	–••–
G	––•	Y	–•––
H	••••	Z	––••
I	••	1	•––––
J	•–––	2	••–––
K	–•–	3	•••––
L	•–••	4	••••–
M	––	5	•••••
N	–•	6	–••••
O	–––	7	––•••
P	•––•	8	–––••
Q	––•–	9	––––•
R	•–•	0	–––––
.(period)	•–•–•–		
?	••––••		

In DNA the rungs of the ladder carry the coded message. A, T, C, and G are the parts of the code. By arranging them in different ways, different messages are given.

G-C
A-T } gives the cell one message.
A-T

A-T
G-C } gives the cell another message.
A-T

Reading 6. The Living Code

1. Get the class to suggest other codes. Braille, semaphore systems, flashing lights on a lighthouse, and symbols designating football plays are some that they might suggest. Ask students for other examples.

→ H 288

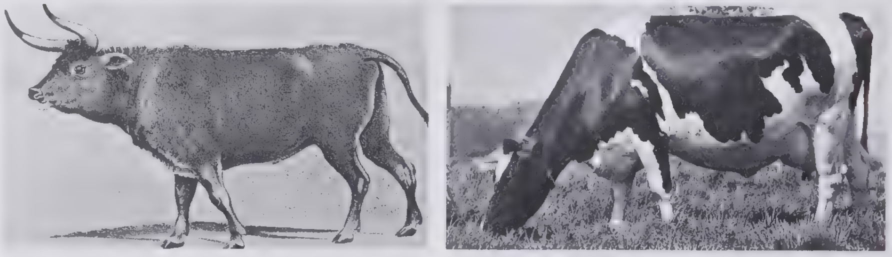
When a cell makes a copy of its DNA, it usually makes an exact copy. Once in a while, it makes a mistake. Maybe it puts the rungs on in the wrong order. Or maybe it leaves out some rungs or puts some extra ones in. Then the message the cell receives is different.

Any change in the DNA is called a **mutation** (*myoo TAY*
2-3. *shuhn*). Most mutations are harmful. Having a mutation is like
having an accident. How often do you have an accident that's good for you? Most mutations make it more difficult for the plant or animal to stay alive. Once in a while a mutation is helpful. If the mutation is in an egg or sperm cell, the change can be passed on to future generations. Some mutations in animals have been useful to man. For example, hornless cattle, animals that produce better meat, and sheep with short legs. Some animal mutations that are useful to man might be harmful to a wild animal.

4. The environment can affect the number of mutations. If a cell is exposed to strong radiation or certain harmful chemicals, the number of mutations increases. While an unborn baby is developing, the cells divide often. New copies of DNA are being made at a great rate. The mother must be careful to keep the baby from being exposed to harmful chemicals or radiation.

Scientists are beginning to understand how the DNA code controls the activities of a cell. Someday they may even be able to change the code. Can you think of any reasons why they would want to?

Before people began breeding cows, they looked like the one on the left. How do you think a wild cow differed from a modern one?



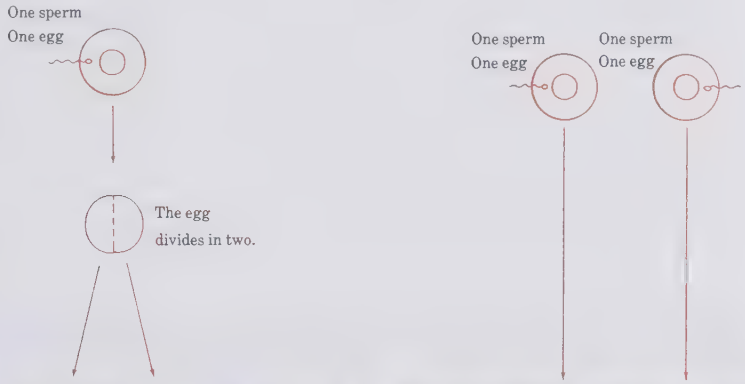
2. The Ancon sheep with short legs was a useful mutation to farmers because it couldn't jump over fences and was easy to confine.
3. Students have studied albinism. This is a mutation.
4. Sickle cell anemia, hemophilia, color blindness are all changes in the DNA that started as mutations.

Use Your Wits!

Part One

When scientists want to study inheritance, they often work with twins. There are two kinds of twins. If both babies develop from a single fertilized egg, they are **identical twins.** If the babies develop from two different fertilized eggs, they are **fraternal twins.** Fraternal twins may be as different as any two children of the same parents.

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 49 or direct students to the Laboratory Supplement.



Identical Twins

Fraternal Twins

1. Which twins have the same DNA in their cells: the identical twins or the fraternal? ______________________

2. Can there be identical twins that have different sexes? No.

3. Can there be fraternal twins that have different sexes? Yes.

4. Why are identical twins so much alike? Same DNA.

5. What could happen after birth to make identical twins different from each other? Accidents, disease, environmental differences.

6. What could happen after birth to make fraternal twins more alike? Dress alike.

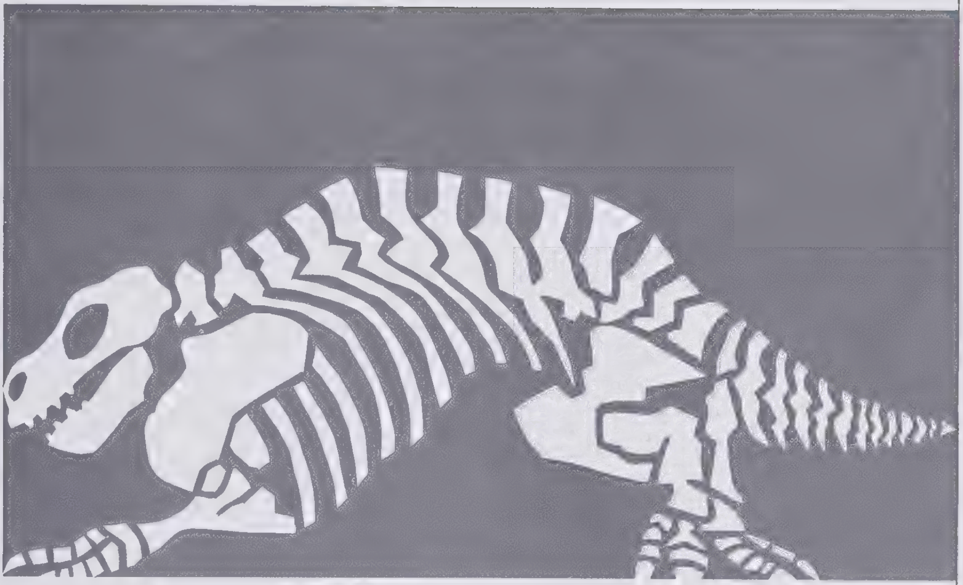
Part Two

Match up the items in Column A and Column B. Write the letter of the best answer in the circle next to the number.

	Column A	*Column B*
e. ○	1. DNA	a. an inherited trait that will show
g. ○	2. 46	b. X and Y chromosomes
a. ○	3. dominant trait	c. an inherited trait that may be hidden
i. ○	4. mutation	d. an inherited trait
h. ○	5. identical twins	e. carries the biological code
c. ○	6. recessive trait	f. rungs of DNA ladder
b. ○	7. determines sex	g. the number of chromosomes in human cells
f. ○	8. A-T-C-G	h. develop from one fertilized egg
j. ○	9. egg	i. a change in the DNA
d. ○	10. nearsightedness	j. the female reproductive cell

14 Evolution

H 289



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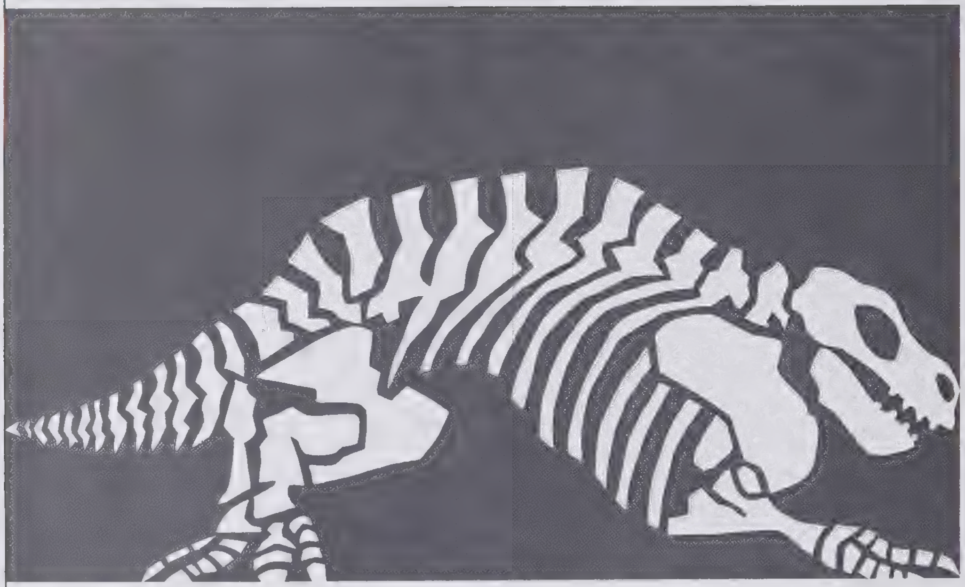
H 290



Hard Cover Folios Preceded by H

H 291

Reading

1. New Kinds From Old

Dinosaurs like this one have not walked the earth for about 135 million years — fortunately for us.

1. THERE HAVE BEEN plants and animals on the earth for hundreds of millions of years. We know this because they left traces behind. The traces are called **fossils**. Fossils show us that some kinds — dinosaurs for example — have completely disappeared. But other kinds are like modern living things. The first plants and animals lived in the sea. Fossils show it was a long time before they moved onto the land. In other words, living things have changed a lot since life began.

The ways that living things have changed is called **evolution** (*EHV uh loo shuhn*). The word evolution means "turning from one thing into another." Biologists learn about evolution by studying fossils and also living animals and plants.

Many clues show that animals and plants have changed. For example, many of them still have parts that they no longer use. Whales, dolphins, and some large snakes still have small leg bones inside their bodies. But none of them have legs. It seems likely

H 292

Reading 1. New Kinds From Old

1. A fossil is the remains or the impression of a once-living organism. It can be a footprint, shell, leaf, wood, or bone. Natural casts and mineral replacements are fossils.

that the animals they came from did have legs a long time ago.

The changes that turned these parts into useless leftovers took place over many millions of years. The big question is: How did the changes happen?

One of the most important reasons for changes is that a change takes place in an animal's or plant's DNA. This usually happens by accident. Often, we can't explain why it happens. If the DNA changes in the eggs, sperms, or pollen, the offspring are different from their parents. Most of the time the change, or mutation, does not help the animal or plant to survive. Sometimes, it blocks reproduction. Or the changed animal or plant cannot compete with others very successfully. One way or another, such changed animals and plants die out.

But from time to time, a mutation gives the changed animal or plant a better chance to survive. The change is passed on to its offspring, and they survive better, too. After a long time, they take the place of unchanged animals or plants of the same kind.

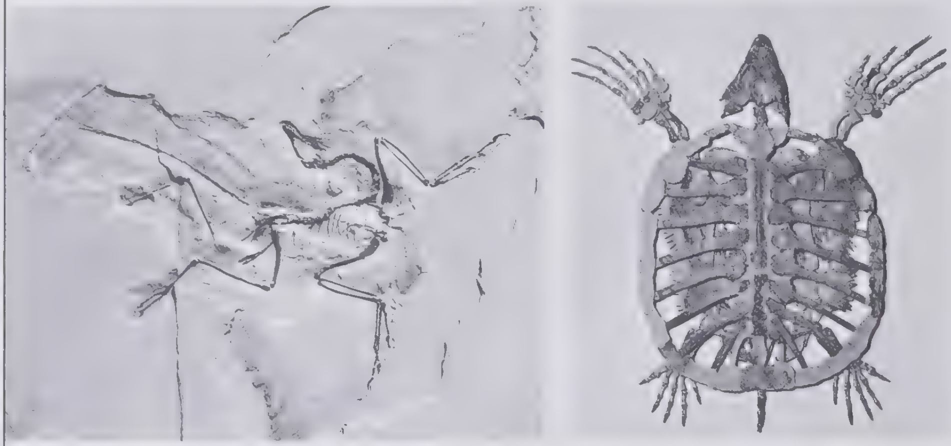
2. Scientists believe that thousands of years ago, there were giraffes both with long necks and with short necks. At some point, there had been a change in giraffes' DNA that gave them necks of different lengths.

→ H 293

The long-necked giraffes had an easier time finding food. They could reach the leaves high up in the trees. They lived longer and had more chances to reproduce. So did their offspring. After thousands of years, the only giraffes to survive were long-necked giraffes. Their DNA for short necks disappeared.

3. All of life seems to have been changing. In most cases, the changes have happened very slowly. Do you think that living things, including human beings, are changing still?

The fossil on the right was a giant sea turtle 80 million years ago. What kind of animal made the fossil on the left?



2. Make the point that variety in living things is the basis for natural selection. The story of the giraffes illustrates this.

3. The story of the natural selection of the peppered moth is interesting. See BSCS Blue Version page 551, 3d edition.

Exploration 2. Fossils

Overview

In this activity students will observe fossils and come up with some conclusions on the different ways fossils are formed. Student answers do not have to be the same.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) discuss the importance of fossil evidence for the theory of evolution.

(2) describe and demonstrate fossil formation.

(3) define or describe *variation* and *mutation* in organisms.

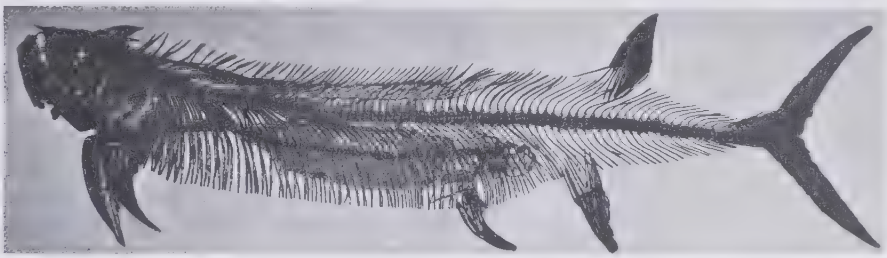
Exploration

2. Fossils

1. Part One Puzzling Out Some of the Pieces

YOUR TEACHER will have some fossils or pictures of fossils for you to look at. Study as many as you can. What parts of plants and animals can you see? (You don't have to name the plants or animals.)

Answers will vary.



The fossil fish in the picture were found in Kansas. The big one is more than 4 meters long. The fish inside it is about 2 meters long. The large fish swallowed the smaller fish 90 million years ago.

How do you think this fossil could have formed? Fish may have died from indigestion. Then it sank to muddy bottom and was preserved.

Today, Kansas is mostly flat farming land in the middle of America. What does the fossil tell you about this area 90 million years ago?

The land was underwater.

Materials for Each Group

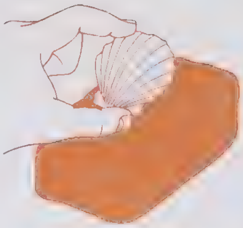
collections of fossils
pictures of fossils
modeling clay
newspaper

Time

Two days

1. Part One Fossils can be purchased from a supply house, a museum, or a hobby shop. They can also be found in coal or slate. In some areas there are special fossil-collecting spots. If you know of one, a trip to it would be exciting.

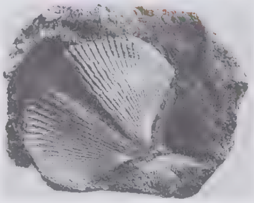
2. Part Two How Are Fossils Made?



You will need some soft clay. Press a leaf, a shell, a dead insect, or a bone into the clay. When the clay has hardened, pull it off carefully. What do you see in your "rock"? You see an impression of the organism used.

The hard clay represents rock, because rock too was soft once.

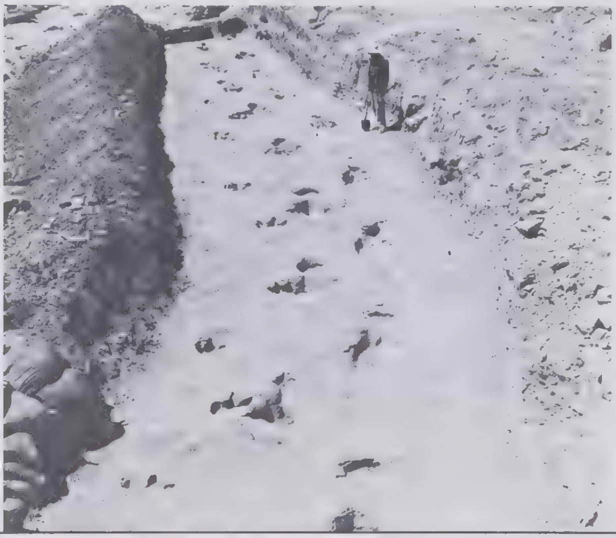
What you are making now could be called a fossil by someone who found it far in the future.



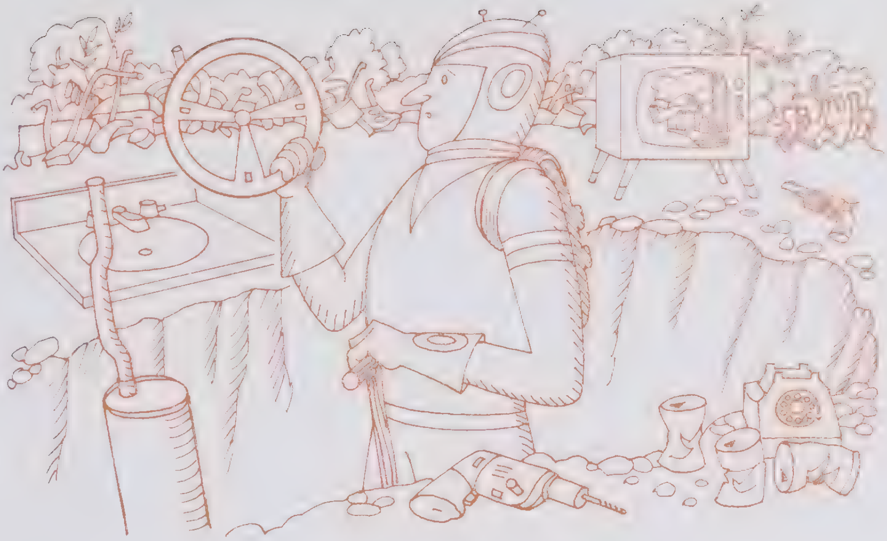
Can you use your clay to make a fossil like this one?

What might have happened, millions of years ago, to make a record such as you just made? Students speculate.

Can you guess how the dinosaur's footprints in the photo below became a fossil? It stepped in mud that eventually hardened into rock.



2. Part Two Regular nondrying modeling clay is the easiest material to use. It will never get really hard. If you use plaster of Paris, it must be mixed with water to the consistency of sour cream and poured into a flat container. Jar lids make good containers. When it dries, it makes a permanent print that can be painted and hung. Newspapers will protect the desk tops when you work with either clay or plaster. Have on hand shells, dead insects, leaves of plants, pieces of wood, pieces of fur, and anything else firm enough to make an impression in clay.



Part Three Who Were You?

Along with fossils of early human beings, there are sometimes tools and other things that they used. These tell us something about the way the people lived. Suppose a scientist 5000 years from now is digging where you live and happens to hit a garbage dump. He or she finds the things you can see in the picture. What do you think the scientist could tell about us from these things? Students speculate.

← H 295

Which things might fool the scientist if he or she tried to guess what they were for? Why do you think so? Let students speculate.

H 296

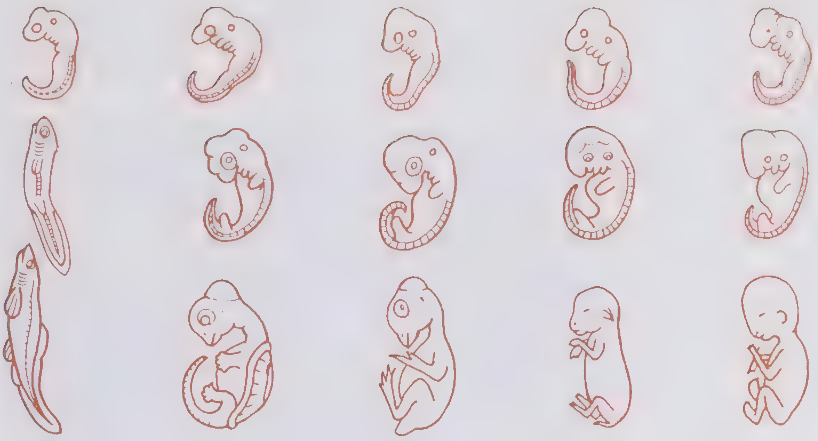
Check Yourself

1. Why do most scientists think that living things have changed over millions of years? Fossils give clues. In many ways fossils resemble organisms that are living today.

2. Most of the plants and animals that have lived on earth have not become fossils. Why not? Soft bodies. They decayed after they died.

3. What might happen to a plant or animal if a mutation makes it harder for the plant or animal to survive? It will become extinct.

4. What might happen to a plant or animal if it does not change but its environment does? It will become extinct.



5. The study of embryos is one of the clues that shows that animals are related to each other. Here are some stages in the growth of the embryos of a fish, a turtle, a chicken, a rabbit, and a human being.

   Can you tell which is which in the first row? No.

   Can you tell which is which in the second row? No.

   Can you tell which is the fish, the turtle, the chicken, the rabbit, and the human being by looking at the third row? If you can, put the right name under each embryo. Yes.

6. Can you think of a mutation that would help human beings to survive? Let students speculate. Example: How about a combination of gills and lungs?

Research You Can Do

You might enjoy reading these books about evolution: *Evidence of Evolution* by Nicholas Hotton, and *The First Book of Stone Age Man* by Alice Dickinson.

At Dinosaur National Monument workers chip through a mountain of bones.

Reading
3. The Theory of Evolution

Cavemen in France painted these animals about 20,000 years ago. The animals died out long ago. But we are probably still evolving.

One of the people who did most to give us the theory of evolution was an Englishman named Charles Darwin. Darwin was born on the same day as Abraham Lincoln, but his life was very different.

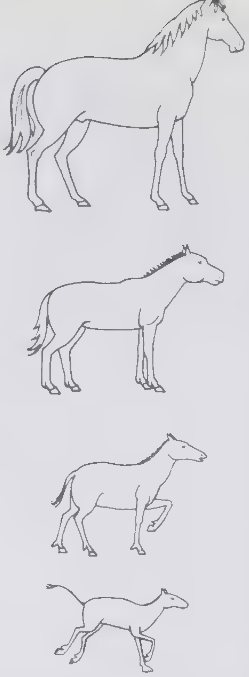
1. When he was 22 years old, Darwin joined an English ship for a scientific exploration around the world. The voyage took five years. During those five years, Darwin studied the fossils and living things he came across. He kept careful records of what he saw and what he thought. He began to think about the ways that living things are alike and the ways they are different.

2. When he got back to England, Darwin worked over his ideas for many years. He found an explanation for the differences he had seen in fossils and in living animals and plants. Darwin said that the animals and plants we know now did not suddenly appear. They were new forms of older animals and plants. And the changes that led to new living things are still happening now. This idea changed the thinking of scientists and many other people.

Reading 3. The Theory of Evolution

1. Fossils are the clues that give us information about evolution.

2. The simplest way to explain evolution is that living things have changed due to natural selection, which is possible only because there is a variety of traits among the organisms of any species.



The horse evolved as its environment changed from forest to plains.

You can learn more about Darwin in a book by George Cooper, *Charles Darwin: Voyager-Naturalist.*

Living things change in many different ways. Some living things seem to evolve by getting bigger. Fossils show that the first horses were fairly small. Our modern horses seem to have evolved from an animal the size of a fox.

Some living things seem to evolve by getting smaller. Modern ferns grow from about half a meter to a meter tall. But our small ferns seem to have evolved from giant ferns that were the size of trees.

Some living things seem to evolve by getting more complicated. Triceratops was one of the dinosaurs. It seems to have evolved from a much simpler dinosaur that looked like a lizard.

Some living things seem to evolve by getting simpler. Sometimes, for instance, they lose parts of their bodies that they don't need. Snakes seem to have evolved from animals that had legs. Our modern flies have only two wings, while flies that lived much earlier used four.

Sometimes, an animal or plant seems to evolve in two completely different directions. Dogs and bears both seem to have evolved from the same animal.

Sometimes, different things will evolve so that they become more alike. Birds and bats and insects all evolved with wings, even though they came from very different animals. Their wings are not built in the same way, but they do the same job — they get the animals flying.

Evolution happens in many different ways. It seems to have been going on for a long time, and it is likely to keep going on so long as there are living things to evolve.

Some dinosaurs were as big as houses. But the biggest lizard alive today is the Komodo dragon. It's three meters long.

Exploration 4. Fossils and Evolution

Overview

This Exploration will give the students opportunities in problem-solving. They will need to explain or defend their positions on how the fossils should be arranged. This Exploration should follow the reading "The Theory of Evolution." If members of the class made their own fossils, they will be able to visualize how the fossils in this lesson could have been trapped in rock layers.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) define or describe the theory of evolution.

(2) interpret fossil evidence in support of the theory of evolution.

Materials for Each Group

scissors
paste or cellophane tape

Time

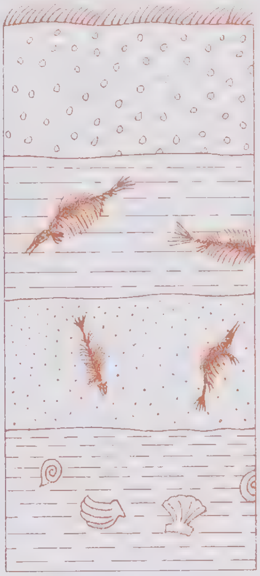
Three days

1. Cut out each fossil as a block rather than following its shape with the scissors.

2. Take a minute or two before starting this Activity to have the class point out ways that the "fossils" differ from each other. Allow time to cut out the diagrams that represent fossils.

H 299

Exploration
4. Fossils and Evolution



HOW CAN YOU TELL the age of different fossils? The layers of rock where the fossils are found give you a clue. Usually, the oldest fossils will be in the lowest layer of rock. You can also guess that fossils in the same layer of rock are all the same age.

This picture shows fossils of shells and fish. They were buried in sand that later turned to rock. The shells are lower than the fish. So the shell fossils are probably older than the fish fossils.

Today you are going to put some fossils in order from oldest to youngest. Then you can see if they seem to have evolved.

1-2. The drawings in the picture on page 431 stand for different kinds of fossils. Fossils that are the same color came from the same layer of rock. But you don't know which of the layers is the lowest. That is what you have to find out. Follow these instructions.

( ) 1. Cut out each fossil.

3. ( ) 2. Sort out the fossils into groups by shape. Put the triangles in one group, the circles in another group, and so on. The fossils in one group will have the same shape, but they may be different in other ways.

4. ( ) 3. You are going to put the fossils in order to show how they have changed. Here is a clue. The circle fossils changed by getting bigger. Make a row of the circle fossils with the smallest at the bottom and the biggest at the top. Now you know that the color of the bottom fossil is the color of the oldest layer of rock.

5. ( ) 4. Take the triangle fossils and match them by color with the circle fossils. Remember that fossils of the same color were found in the same layer of rock.

( ) 5. Match up the other groups of fossils by color in the same way. When you have finished, check to make sure that all of the fossils in each layer are the same color.

( ) 6. When you are sure you are right, stick the fossils on the chart on page 433. Keep the fossils in the right layers.

You already know that the circle fossils evolved by getting bigger.

Which fossils evolved by getting smaller? Write the answer here or draw it in. Triangles.

Which fossils evolved by getting more complicated? S - V - H - B or O - X - K - A

H 300

3. Give the students the idea that there is no one right way to arrange the fossils, but that they will have to rationally support any arrangement they make.

4. Be sure that everyone starts by arranging the circles as suggested.

5. The triangles will give a bit more trouble as there are more than four triangles. Here's where you may get different ideas on how to arrange them. Point out flaws that you see in reasoning but encourage differences of opinion. For instance, the colors have to be lined up correctly.

Reminder: Prepare nutrient agar and plates for Chapter 15.

Which fossils evolved by getting simpler? R - T - I - E.

Which two fossils might have evolved from the same living thing? E and C both may have R as a common ancestor.

Which two fossils started out differently but evolved the same parts? A and B.

Which fossil may have died out? J or M depending on arrangement.

Which color stands for the oldest layer of rock — the dark red, light red, white, or spots? White.

Check Yourself

1. Who was Charles Darwin? The scientist that studied plants and animals and whose ideas resulted in the theory of evolution.

2. What living things do you know that evolved

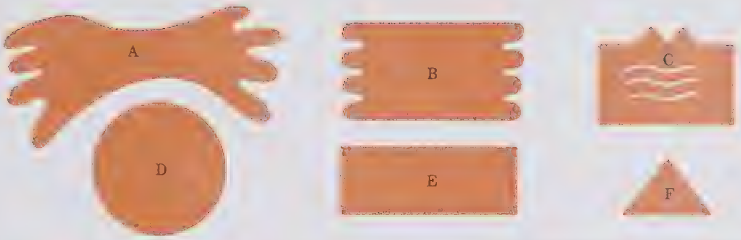
   a. by getting bigger? Horse.

   b. by getting smaller? Ferns.

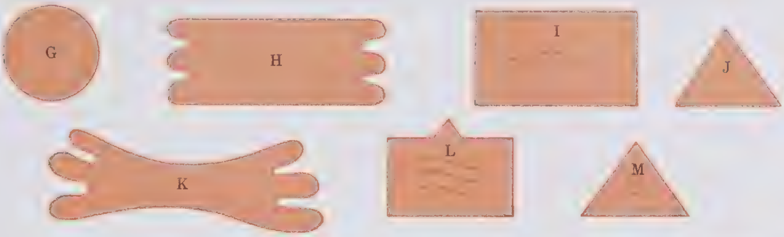
   c. by getting more complicated? Triceratops. Simple dinosaurs evolved into Triceratops and birds.

   d. by getting simpler? Snake.

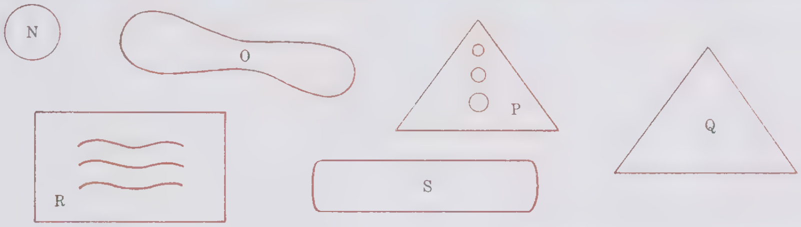
Hard cover users: To reproduce the drawing for this Exploration please turn to page T 68 or direct students to the Laboratory Supplement.



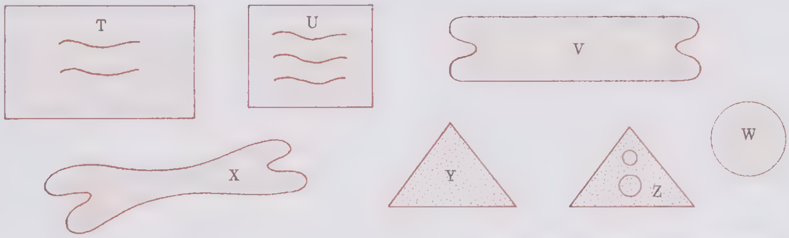
These fossils were found in the same layer of rock.



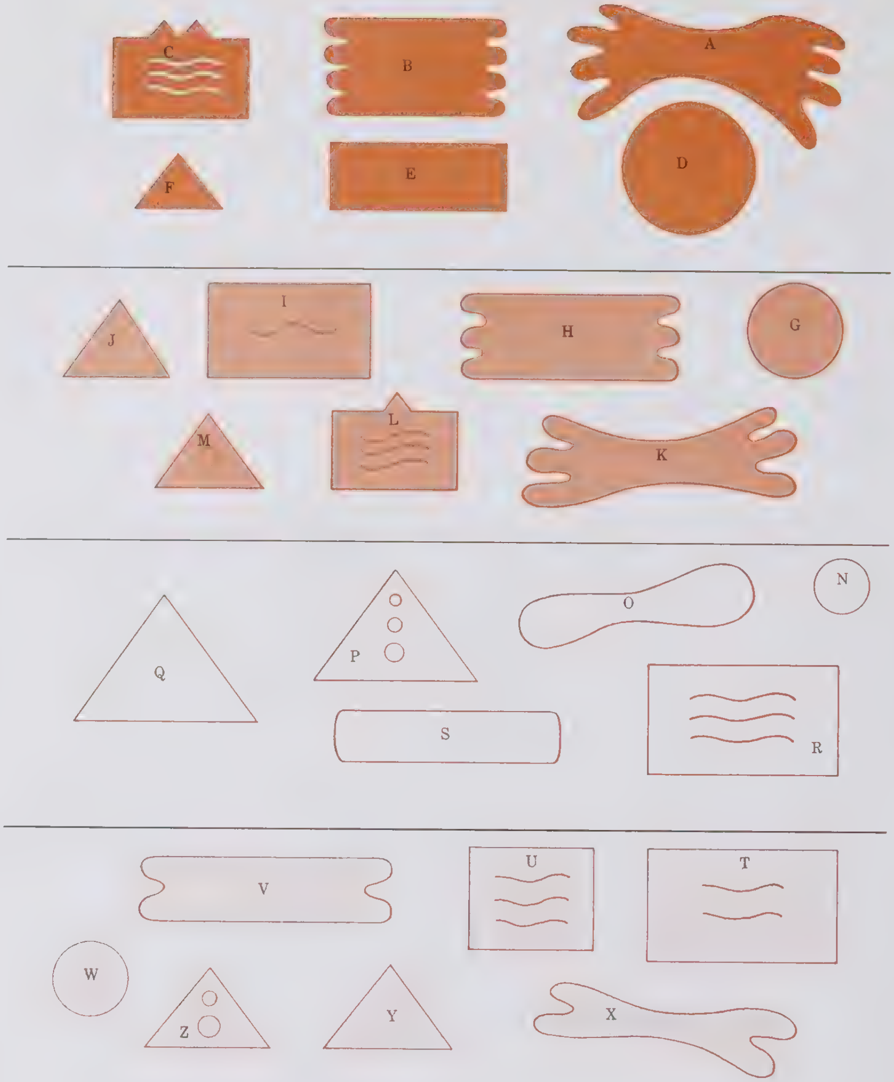
These fossils were found in the same layer of rock.



These fossils were found in the same layer of rock.



These fossils were found in the same layer of rock.


C
B
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K
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S
R
V
U
T
W
Z
Y
X

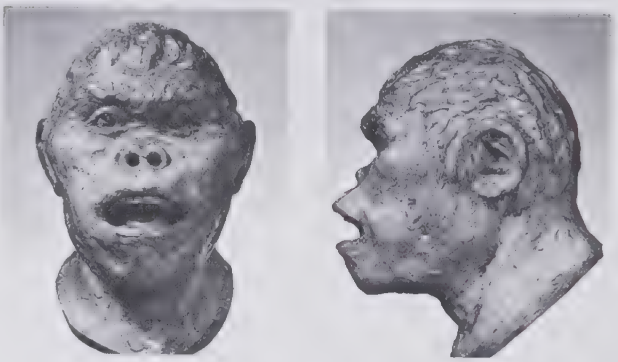
4
3
2
1 The oldest layer

Hard cover users: To reproduce the chart for this Exploration turn to page T 69 or direct students to the Laboratory Supplement.

Research You Can Do

During his voyage around the world, Charles Darwin spent some time on the Galapagos (*guh LAH puh guhs*) Islands. These are a group of islands off the coast of South America. The living things on the Galapagos Islands are unusual. Many kinds of animals found there are not found anywhere else in the world. You might want to find out more about them.

Fossils of some of the earliest human beings were found in East Africa by a family team of British scientists, Dr. Louis Leakey, his wife Mary, and their son Richard. You might want to find out about the early human beings and how they may have evolved into you.



Modern men and women probably evolved from an animal that looked like this. It lived in Africa about two million years ago.

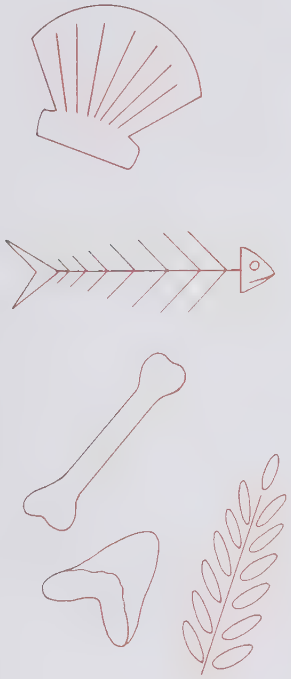
Part One

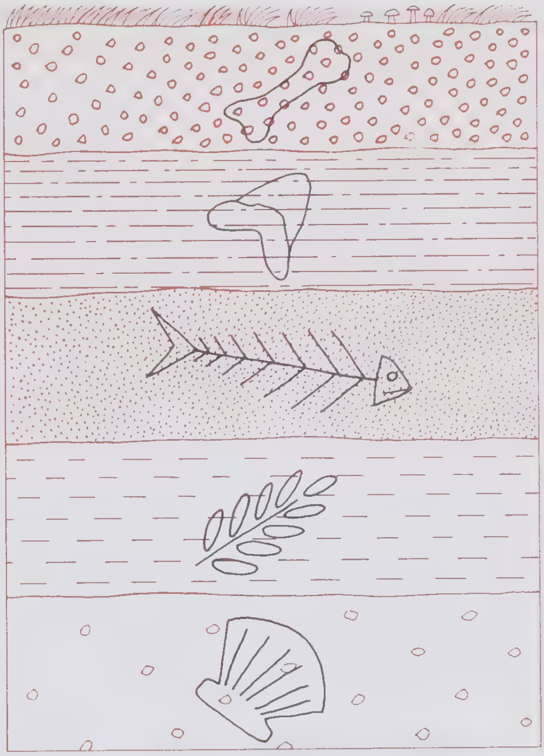
The five fossils shown below were found in different layers of rock.

The shell fossil is older than the fish fossil.
The bone fossil is from a modern horse.
The tooth fossil is from an extinct ancestor of the horse.
The leaf fossil is from the earliest known land plant.

Look at the diagram that has five layers of rock. Draw each of the five fossils in the layer where it was probably found. Be ready to tell why you think each one belongs where you put it.

Answers will vary.



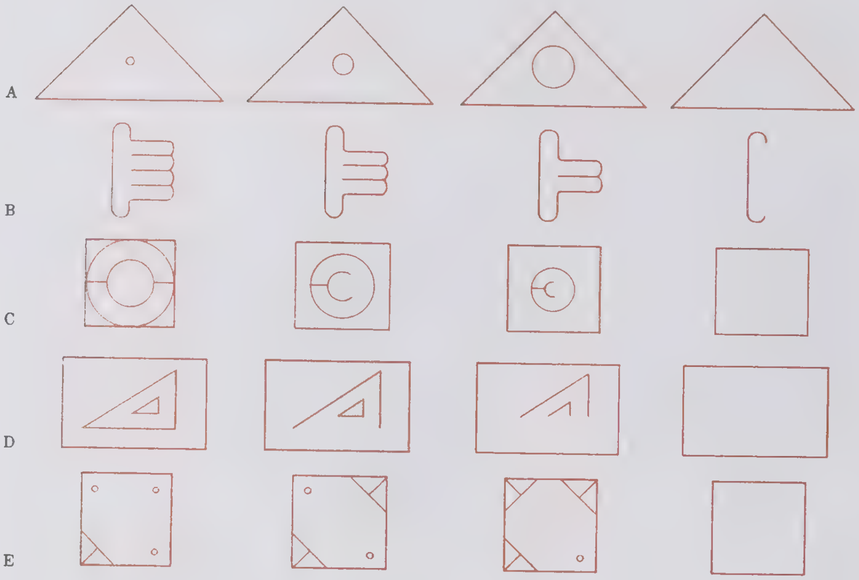


Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 51 or direct students to the Laboratory Supplement.

Part Two

Pretend these shapes represent fossils. Use your imagination and draw the last change.

Compare your drawings with those of other people in your class.



Overview of Unit Four How You Can Keep Healthy

This unit is a survey of the most common disease-forming organisms as well as of the ways that the body defends itself against them. With the help of medical science, the major emphasis throughout the unit is on teenage health problems and the need for preventive medicine.

In the first two Explorations the class works with bacteria from the environment and with antibiotics. The observations suggested are those that are used to help identify bacteria and those that will reinforce the idea that bacteria are around us and will multiply rapidly under the right conditions.

A look at the students' own personal history of immunization starts with "shots" that are given at six months of age through smallpox vaccination, polio and measles immunization, and the tine test for tuberculosis.

The students should be familiar with all of these, and the teacher has the chance to point up the importance of each one. Some students resist the tine test and others misunderstand its purpose. The questions on measles were included because many city people do not take advantage of the protection given by the measles immunization program.

The last chapter should not be omitted. Preventive medicine may be a totally unfamiliar concept to your students. Many of them will not be aware of the simplest techniques of preventive health care or of the community facilities available. The two Explorations are designed to elicit the information they need, and to stress the fact that the maintenance of good health is the concern and responsibility of the individual. Again, the major emphasis is on the students' immediate concerns.

One vitally important area not covered in this section of the student text is drug abuse. This is not an oversight. There are many complex problems involved in drug education. Indeed, in recent years there has been widespread criticism of the content and approach of almost all currently available programs. (See, for instance, the report of the President's Council on Drug Abuse, available from the Government Printing Office.) Although much effort has been devoted to development of satisfactory materials, no acceptable programs are available at this point.

Furthermore, any treatment of drug problems in a text such as this would necessarily be sketchy and, at best, superficial. Clearly, a superficial approach could be worse than none at all. In addition, research has shown that one of the basic problems in drug education is community indifference or resistance. The first step seems to be needed at the community level rather than in the classroom. It is to this goal that the major official effort has been directed by the Office of Health, Education, and Welfare, in such programs as *Help Communities Help Themselves.*

If you feel that drug education is necessary and possible for your students, we suggest that you start reading the President's Council report. The Federal Drug Administration has a Special Action Office for Drug Abuse Prevention, which also furnishes material. Write to 712 Jackson Place, Washington, D.C., 20506.

Sources for drug education materials are widely available; we would strongly recommend *The National Drug Reporter,* published by the National Coordinating Council on Drug Education, 1526 Eighteenth Street, N.W., Washington, DC 20036, and *The Journal,* published monthly by the Addiction Research Foundation, 33 Russell Street, Toronto 179, Ontario, Canada, which contain not only news of developments in the drug field, but also critical reviews of drug education materials.

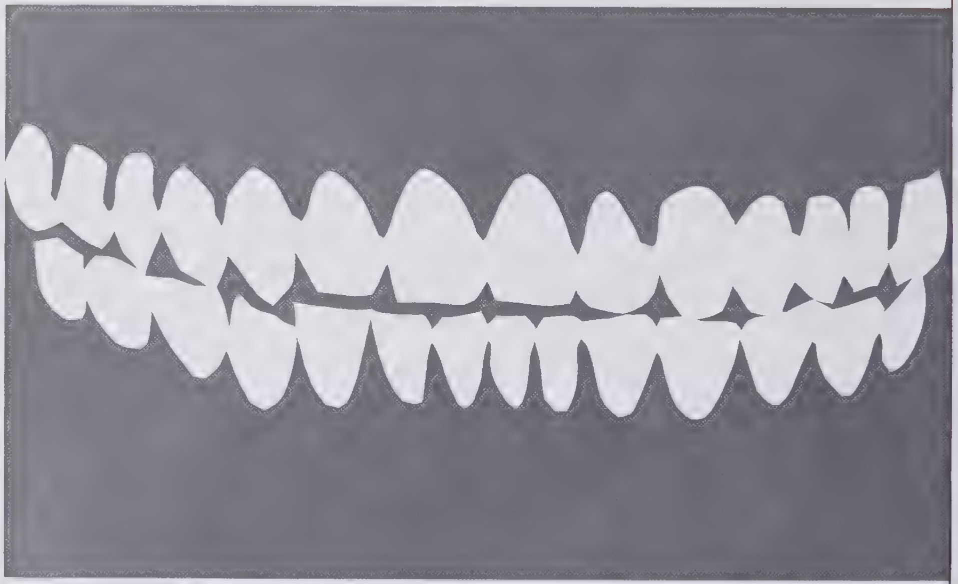
Although none of the topics in this unit is covered in depth, we have tried to be forthright and present the facts with little preaching. We hope that the students will carry on the discussion. Their interest and cooperation will decide how much time should be spent on this material.

Unit Four

How You Can Keep Healthy

15 Germs and Antibiotics

H 303



← H 305

Reading

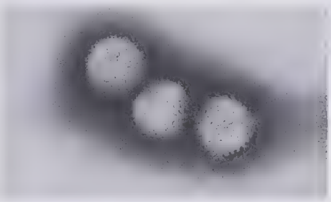
1. The Sickening Gang

Your head aches. You feel hot one minute and cold the next. You can't stop sneezing. Your throat is so sore you can't talk. You break out in a rash! Just then a TV actor in a white coat appears on the screen with miracle cold pills.

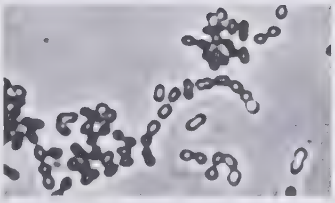
Wait! Before you do anything, you should know why your body isn't working just right.

1. Often when you get sick the troublemakers are germs such as bacteria and viruses. They are so small you need a microscope to see one. But you can also get sick from things that aren't germs. You can get sick from something as big as a worm.

Here are some of the living things that cause disease. You can put them on your UNWANTED list.

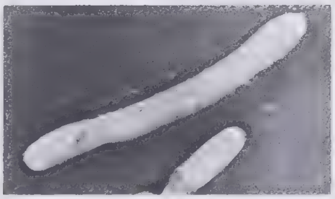


This is a cold ***virus*** (VY ruhs) *magnified 100,000 times. Viruses are the smallest and simplest living things. Flu, measles, polio, chicken pox, and colds are caused by viruses.*



Walter Dawn

Bacteria are one-celled living things that are bigger than viruses. Some of the round bacteria cause sore throats and skin infections. × *1600*



Different kinds of rod-shaped bacteria cause typhoid fever and lockjaw. The one you see here causes tuberculosis (TB). × *12,000*

Reading 1. The Sickening Gang

1. This is a survey of some of the disease-causing organisms.

Microscopic plants like these are called **funguses** (FUNG guhses). *They are the cause of athlete's foot and ringworm.* × 200

This is a tapeworm. It might live in someone's intestines and grow to be six meters long. Tapeworms absorb digested food from the animals they live in. That makes the victims tired all the time.

→ H 306

2-3. Bacteria and viruses are found almost everywhere. Most of them don't cause diseases. In fact, some of them are very helpful.

4. For the other germs that cause diseases, your body has some special defenses. The first line of defense is your skin. If your skin is not scratched or cut, germs can't get through it. Although the mouth and nose lead to the inside of the body, germs cannot pass through without a fight. The nose has hairs and a sticky lining that trap germs. Many germs are killed by acid in the stomach.

There are other defenders inside your body. White blood cells fight infection. Blood plasma contains chemicals that help in the fight against disease. And germs can be removed from the blood as it goes through the liver.

5. Even when all your defenses are working, many germs still manage to live in your body. They can live there for months or years unnoticed. Then suddenly you get sick. Doctors are not sure what triggers the illness. Perhaps not eating the right foods, not getting enough sleep, or even emotional problems with family or friends. Some germs can act even when you are strong and happy. Others attack when you are weak or tired.

2. Some bacteria in the large intestine are responsible for synthesizing vitamins.

3. Cheese-making, tanning of leather, wine-making, and aging of meats are some of the ways that people make use of microorganisms.

4. Some diseases are caused by a breakdown in the parts of the body. We can't blame other organisms for all of our ills.

5. Parasitic worms enter the body as microscopic eggs that develop and grow inside the body.

Exploration 2. Surrounded by Bacteria

Overview

The objective of this activity is to prove that bacteria are all around us and to show how one bacterium can be encouraged to grow into a colony. Some of the characteristics by which bacteria can be identified are included. Students' results will be valid if care is used in following instructions. Students will equate bacteria with illness. Part of your job will be to broaden their outlook.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) grow cultures of bacteria on agar and make accurate observations of them.

2. Surrounded by Bacteria

Bacteria growing on agar. There are halos around each colony. The halos show where the bacteria have digested part of the agar.

1. TODAY YOU will collect bacteria, grow them, and study them. First, you must find the bacteria and give them a good environment. You can't see one bacterium without a microscope. But one bacterium can divide many times and form a **colony.** You will be
2. able to see the colony because there will be hundreds of thousands of bacteria in one spot.

You will grow your bacteria on a jelly called **agar** (*AH gahr*). The agar has already been put in the dishes that you will work with. The agar and the dishes were also sterilized. This was done by heating until all the living things in them were killed.

Each group of students will have two sterilized covered dishes to work with. Remember, bacteria are *everywhere.* They are in your mouth, on your hands and clothes, on money, even in the air and drinking water. Try touching the agar with something you think has bacteria on it. Or think of another way to get bacteria

(2) identify colonies of bacteria.
(3) predict the rate of growth of bacteria.

Materials for Each Group

petri dishes
agar, nutrient
hand lens

Time

Three days

1. Both agar and petri dishes must be sterile. A pressure cooker can substitute for an autoclave when you sterilize. Sterile dishes that are disposable can be purchased. They must be kept wrapped until they are used and then disposed of carefully to avoid contamination. Sometimes a hospital will supply you with sterile dishes in which nutrient agar has already been poured.

2. Caution the students not to take the tops off the dishes. If there is some chance that they will forget, tape the top to the bottom. To help avoid duplication when the students expose their plates, put a list on the board as each group decides what it will do.

Hard cover users: To reproduce the chart for this Exploration turn to page T 70 or direct students to the Laboratory Supplement.

into the dish. When you open the dish, try to keep the top off as short a time as possible.

3. Each group can choose a different place to collect bacteria. Then everybody can share the results. Your teacher will help you decide where to collect the bacteria.

4. One covered dish should be kept untouched and used as a control for the whole class.

Label your dishes with your group number. Also write A on one dish and B on the other so you won't get them mixed up. Then put all of the dishes (including the control) in a warm, dark place.

Fill in the chart to show where each group collected bacteria for its dishes.

Dishes		Source of Bacteria	Number of Colonies on Each Plate					
			Day 1	*Day 2*	*Day 3*	*Day 4*	*Day 5*	*Day 6*
Group 1	*A*	**Answers will vary.**						
	B							
Group 2	*A*							
	B							
Group 3	*A*							
	B							
Group 4	*A*							
	B							
Group 5	*A*							
	B							
CONTROL								

Look at the dishes each day for a week. DO NOT TAKE THE TOPS OFF. Each day count the number of bacterial colonies that you see on each of your dishes. Put those numbers on the chart. Share your results with the rest of the class so everyone can complete his chart.

3. Get the class to make suggestions and to make their own decisions. If you have to start them off, some ideas are: dust, soil from a plant, scraping from under a fingernail, a hair, coin, piece of tissue, or a bobby pin. These can be put on agar and left there. The eraser from a pencil, comb, lipstick, doorknob, finger tip, dishtowel, or clean silverware from the cafeteria can be touched gently to agar and taken away. A few drops of milk, tap water, fish tank water, or saliva can be placed on the agar with a dropper.

4. It is possible that the control dish will show some bacterial growth. It is difficult to maintain sterile conditions in the classroom.

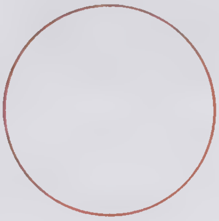
5. At the end of the activity, put petri dishes and contents into an autoclave to sterilize them before washing them. Although we expect to pick up nonpathogenic bacteria in this activity, always handle the petri dishes as if they contained pathogens.

Note: On p. 444 (softback text) the colony on the left grows large (center) and begins to be overgrown by the second kind of bacteria. The second colony overgrows the first (right).

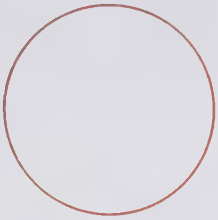
In which dish did the largest number of colonies grow? Varies.

In which dish did the smallest number of colonies grow? Varies.

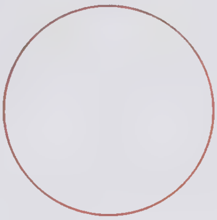
In the diagrams below, put dots to show where colonies are growing in your two dishes. Do the same thing for the control.



Dish A



Dish B



Control

Use a hand lens to observe one colony carefully. KEEP THE TOP ON YOUR DISH! On the diagram draw a circle around the one you are studying.

5. Here are some of the questions that a scientist will ask when he or she is studying bacteria. The answers to the questions help to tell what kind of bacteria they are. Answer as many of these questions as you can.

What color is the colony? Varies.

What shape is it? Varies.

Is it larger, smaller, or about the same size as the other colonies on the dish? Varies.

Is it dull or shiny? Varies.

Is it raised above the agar, or is it flat? Varies.

List anything else you notice about the colony. Students list observations.

A bacterium divides to reproduce.

→ H 309

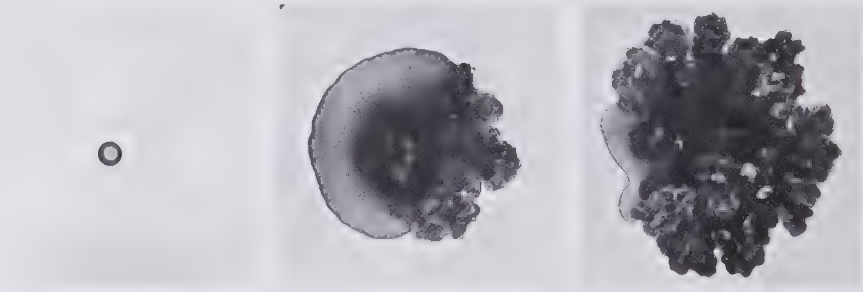
Check Yourself

1. Why were the covered dishes sterilized? To kill any bacteria already on them.

2. Where did your bacteria get their food and water? From the agar. Food was mixed with the agar.

3. What did you learn from the control in this experiment? The bacteria come from the contaminant and not from the agar.

How fast they grow! These pictures of bacterial colonies were taken during four days. Can you tell what's happening here?



Photos by Walter Dawn

4. Since bacteria are all around us, why don't we get sick more often? Most bacteria are not disease-causing.

5. Since bacteria are all around us, why don't they form colonies on our books and our clothing? They need food, moisture, and proper temperature.

6. One bacterium may divide in two every half hour. Suppose you start with one. Record in this table the number of bacteria you would have at the end of each half hour for five hours.

Time	Number of Bacteria
½ hour	2
1 hour	4
1½ hours	8
2 hours	16
2½ hours	32
3 hours	64
3½ hours	128
4 hours	256
4½ hours	512
5 hours	1024

Research You Can Do

You may want to show that the spots you saw on the agar are really colonies of bacteria. How do you think you could do this? Talk your ideas over with your teacher before you try this experiment.

Make slide using material from colony, then view under microscope. If possible use oil immersion lens.

Bacteria give many foods their taste. You can make slides that will let you see these bacteria. Sour cream, yogurt, and fresh sauerkraut have bacteria that you can see with the high power lens of your microscope.

Exploration 3. Some Germ Fighters

Overview

Antibiotics are part of everyday life, but testing their specificity will introduce a new idea to the class. Some skill in handling material, careful work, and clear thinking are the goals that will make this lesson a success. The class handled petri dishes with bacteria in the last activity. Everyone will have heard about penicillin, but the other antibiotics will be unfamiliar names. By now we hope your students will be looking for a control in an experiment.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) define or describe *antibiotics.*

Materials for Each Group

petri dishes
forceps (soaking in 70% alcohol)
agar, nutrient
Bacto-disks (disks soaked in antibiotics)
nonpathogenic bacteria

3. Some Germ Fighters

1. Doctors know of many chemicals that kill germs or stop them from growing. These chemicals are called **antibiotics** (*AN tih by AHT ihks*). All the antibiotics don't kill all the germs, though. So a doctor has to decide which antibiotic to prescribe for a sick person. Or whether to prescribe any antibiotic at all.

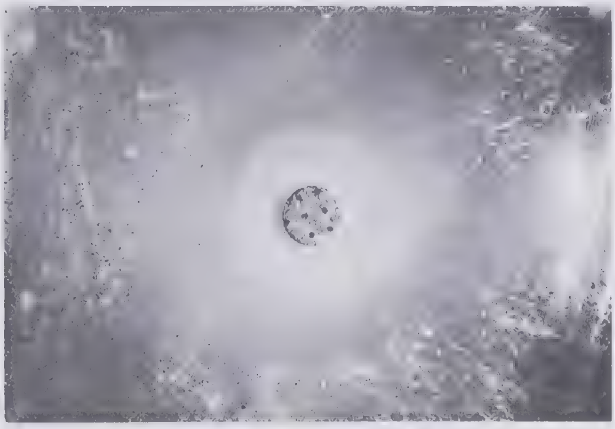
There are good reasons for not giving antibiotics except in serious cases. Some people are allergic to some antibiotics. The antibiotics make them sick. Do you know if you are allergic to any? There is also a danger in using the same antibiotic over and over. Germs may evolve that aren't affected by the antibiotic. Then your doctor has to find a new antibiotic to kill these new germs.

← H 311

2. In today's Exploration you will test several antibiotics. You will find which ones stop bacteria from growing in a dish. You won't be using bacteria that cause diseases. But BE CAREFUL. Don't eat anything while you are in class. Wash your hands at the end of class.

3. Your dish and agar have been sterilized. Bacteria have been spread evenly over the agar. Place small paper discs on this layer of bacteria. They have been soaked in different antibiotics. Use clean forceps to handle the discs.

Cover the dish and put it in a warm dark place. Look at the area around each paper disc every day for two or three days. A clear area means that no bacteria were able to grow there.



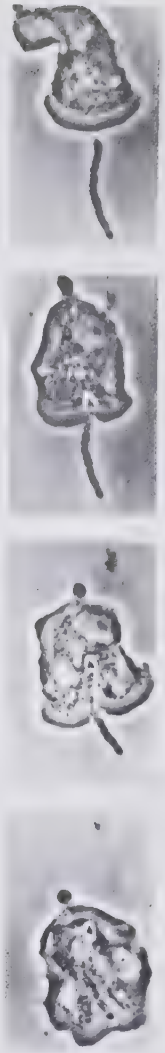
The small disc in this dish of agar was soaked in an antibiotic. How has the antibiotic affected the bread mold in the dish?

Time

Two days

1. The Bacto-disks are soaked in a variety of antibiotics.
2. If you purchase disks individually, choose four or five commonly used antibiotics. Most of them are coded either by color or number to avoid confusion.
3. The bacteria you use should be nonpathogenic. *Serratia marcescens* (red), *Sarcina lutea* (yellow), or any gram-positive nonpathogenic bacteria will work. Bacteria can be purchased from a supply house. One technique for preparing the plates is to prepare a broth of the bacteria and put a loopful of it into the sterile agar just before pouring.

→ H 312



A white blood cell destroying a bacterium. × *2000*

Do you see a clear area around any of the paper discs? Varies.

Which antibiotics stopped the growth of the bacteria in the dish?

Varies.

4. Imagine that the harmless bacteria you used in this test could cause a disease. Which antibiotics would a doctor use to treat a person with the disease? Whichever has the largest clear area around it.

Doctors are usually very busy. They don't have the time to test every germ they want to kill. Besides, tests cost patients a lot of money. So doctors often prescribe an antibiotic that *usually* works, but may not.

Imagine a doctor has a patient with a bad sore throat. He prescribes an antibiotic that usually helps. But in this case it doesn't. How could the doctor find an antibiotic to stop the growth of the sore throat germ? The doctor would grow the germ on agar. Then the doctor would place several antibiotic disks on surface and watch for the one that prevented growth of bacteria.

Where would the doctor get the germs to test with different antibiotics? From the throat of the sick person.

Research You Can Do

About 100 years ago a scientist named Louis Pasteur (*pah STUR*) saved the wine industry in France. The wine makers couldn't figure out why their wine was spoiling. They didn't know that bacteria in the wine were turning it into vinegar. Pasteur told them to heat the wine for a short time to kill the bacteria. His idea worked. Now we pasteurize (heat) raw milk to kill bacteria in it.

Pasteur made many other important discoveries, including a way to prevent rabies. Find out about some of these discoveries. One of the many books on Pasteur is *Louis Pasteur* by Laura N. Wood.

4. Before cleaning the medium out of the glassware, sterilize the plates in a pressure cooker or autoclave.

Exploration 4. Some Ways to Prevent Disease

Overview

This pencil exercise provides a change of pace and is a review of the immunization program that most students were part of as they grew up. The point is made that parents, or the state, or the schools have arranged to care for their health during the early years. As the students get older, they will be responsible for their own health.

If possible, take the class to the school library after you have made arrangements for suitable books and pamphlets to be made available. Guidance will be needed in using an index, table of contents, and card catalogue

Exploration

4. Some Ways to Prevent Disease

Doctors of the World Health Organization vaccinating Tibetans against smallpox. Smallpox is a rare disease in North America now that almost all children get smallpox vaccinations.

1. THIS IS A LIBRARY research lesson. The class will share the responsibility of getting the information that you need.

When you were about one year old you probably got your smallpox **vaccination** (*vak suh NAY shuhn*). How often should you get one?

Only if there is an epidemic.

What is compulsory vaccination? Vaccination that is required by law.

in order to ferret out the information. Your students can show you their vaccination but will not be sure what it is for. They know that baby brothers and sisters are taken to the doctor for "shots" and they may have had the tine test for TB in the last year or so.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) define or describe *vaccination.*

(2) name at least four diseases against which vaccination is effective.

Materials

pencils

Time

Two days

1. If a library is not available, bring books and pamphlets into the classroom. Usually your town library will make books available to you for class use.

Before you were six months old, a doctor gave you shots to protect you against some childhood diseases. Some of these diseases are killers. Find out what these diseases are. Diphtheria, tetanus, whooping cough, measles, polio.

2. How did Dr. Jenner get the idea for the first vaccination? He noticed that milkmaids who had once caught cowpox from the cows that they handled were immune to smallpox. Anyone that caught cowpox from the milkmaids was also immune.

3. Before you entered school most of you were protected from polio. How did you get this protection? Vaccination either by an injection or by vaccine taken by mouth.

What is polio? A disease that attacks the nervous system and sometimes results in paralysis.

Why is it important to have protection against polio before you go to school? It is a communicable disease that most often concerns children.

Who are the two American scientists that discovered vaccines for polio? Jonas Salk and Albert Sabin.

You may have been given a test for tuberculosis in school. What does it mean if you get a red mark on your skin where the test was given? You may have been exposed to TB germs.

→ H 313

2. Metropolitan Insurance Company (Education and Welfare department) has a series of excellent free booklets called "Health Heroes." Send for a set and then select the ones you want to order in class-sized lots. These can be reused. There is a good one on Edward Jenner.

3. In some states vaccination for smallpox is no longer compulsory. The reasons for this change will make a good class discussion.

What does it mean if you don't get a red mark? You don't have TB germs in your body.

Why might you have an X-ray of your chest taken to test for tuberculosis? To determine whether or not you have TB. It is a more accurate method.

There is a vaccine to protect you against a serious disease called measles (*MEE zuhlz*). Many people do not have their children vaccinated against measles. Why should they? Measles is a communicable disease that may cause serious aftereffects and even death.

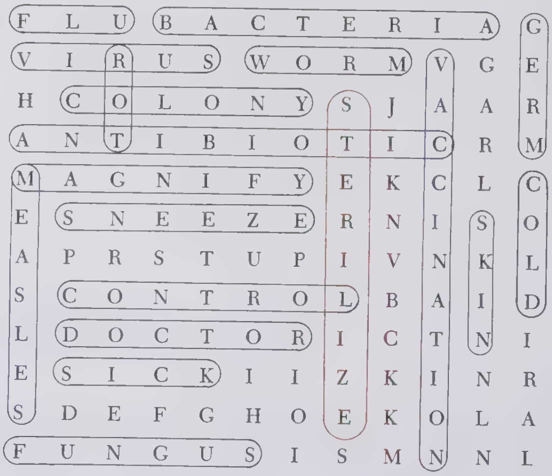
← H 314

Some doctors used to think that people could get blood transfusions from a lamb. Other doctors tried to cure headaches by poking holes in your head. Years from now people will look back on some of our medical practices and find them just as mistaken.

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 53 or direct students to the Laboratory Supplement.

Use Your Wits!

There are 20 words hidden in the puzzle. They are all words that you used in the lessons on disease. The word STERILIZE has been circled for you. How many of the other 19 words can you find?



F	L	U	B	A	C	T	E	R	I	A	G
V	I	R	U	S	W	O	R	M	V	G	E
H	C	O	L	O	N	Y	S	J	A	A	R
A	N	T	I	B	I	O	T	I	C	R	M
M	A	G	N	I	F	Y	E	K	C	L	C
E	S	N	E	E	Z	E	R	N	I	S	O
A	P	R	S	T	U	P	I	V	N	K	L
S	C	O	N	T	R	O	L	B	A	I	D
L	D	O	C	T	O	R	I	C	T	N	I
E	S	I	C	K	I	I	Z	K	I	N	R
S	D	E	F	G	H	O	E	K	O	L	A
F	U	N	G	U	S	I	S	M	N	N	L

16 Preventive Medicine

H 315

T530

H 316

Hard Cover Folios Preceded by H

Reading
1. The Big Killers

1. THERE ARE MANY different kinds of diseases. Many of them are not too serious. If you catch one, you may be ill for just a few days or even weeks. Then you get better and your life goes on as it did before. But some diseases are really serious. They can cripple you. You can even die from them. These are the big killers.

Reading 1. The Big Killers

1. To have a discussion on this topic you might ask students why accidents, and not some disease, are the biggest killers of young people.

H 318

2. We have not always had the same big killers. Hundreds of years ago, one of the biggest killers was a disease called **plague** (*PLAYG*). Plague killed millions of people in Europe and in other parts of the world. Today, plague has almost disappeared. We know what causes it and we know how it is spread. So we can control it.

3. When your parents were children, diseases such as scarlet fever, pneumonia, and polio were big killers. They killed and crippled thousands of people — especially children — every year. But, again, doctors learned how to control them. Many of them are not a serious threat any more. Some diseases, such as polio, are now rare in America.

Instead, we have a new crop of big killers. The biggest killers in the United States today are diseases of the heart and circulatory system. Nearly half the deaths in this country are caused by these diseases. Medical scientists still are not sure what causes them. One thing we do know. The countries with big industries and a high standard of living have more heart disease than so-called backward countries. Heart disease seems to be part of the price we pay for cars, washing machines, and color TV's. Blue-collar workers have an especially high rate of heart disease. These are people such as miners, construction workers, farmers, and factory workers.

Next to heart disease, **cancer** is the big killer. It is hard to tell if more people have cancer now than before. It may always have been a big killer. But until a short time ago, no one had identified this disease. Even now, we know very little about cancer. It is a disease that causes cells to act strangely, as if they were out of control. There may be several different diseases that we call cancer, or several different forms of cancer. Every year a lot of money is spent looking for the causes of cancer and the cure. Once the causes are known, we may be able to control it.

H 319

Another big killer is **stroke.** When someone has a stroke, a blood vessel to the brain is blocked. The brain does not get enough blood and oxygen. Some of the brain's cells stop working or even die. As a result, the people who suffer strokes may not be able to talk or to use some muscles. They may turn into human vegetables, unable to help themselves in any way. Or they may just die.

Another of the big killers is not a disease. Every year, thousands of people are killed and crippled by **accidents.** Burns, accidental poisoning, falls, and mishaps around the home kill more people than any other accidents. Automobile accidents are the biggest killer for young people, far worse than any disease.

Medical scientists are working hard to find ways to control the big killers. But you don't have to wait until new cures are found.

2. As bad as our health problems are, there are some places that are much worse. In many parts of the world impure water and malnutrition are the big problems. Malaria is a worldwide killer.

3. The World Health Organization (WHO) sponsored by the United Nations makes a study of world health. Booklets and pamphlets can be obtained from WHO.

Often, a doctor can help keep a person from getting a serious disease. Or, if the doctor finds out about a disease in time, he or she may be able to keep it from getting serious. That is one reason why everyone should have regular medical checkups.

A small amount of prevention is better than any cure.

Reading

2. Some Teenage Health Problems

1. **Acne** (*AK nee*) isn't one of the big killers. But it is a problem for two out of three teenagers.

The changes in your body that take place at puberty cause acne. The oil glands in the skin produce more oil. And the extra oil can build up under the skin and form pimples.

With more serious cases of acne, pockets of pus can develop under the skin. If you squeeze the pimples, you can spread the problem and cause scars and pits in your skin. If you have a bad case of acne, try to see a doctor who specializes in treating skin.

Some people believe that fried foods or chocolate can make acne worse. This isn't true for everybody. If you find that a few foods make *your* acne worse, don't eat them.

There are two other things you can do to help clear your skin. First, wash your face, chest, and back very carefully and often. A doctor may suggest a special soap to use. Second, girls should not use heavy makeup. It can clog your pores.

Do you have a weight problem? You can try the pinch test to see how much fat you are carrying around. Use the photos to

Reading 2. Some Teenage Health Problems

1. Use discretion in discussing the material in this Reading. Topics of overweight and underweight, acne, and emotional problems may be embarrassing to some members in your class.

← H 321

help you find the best spot to test yourself. Take a big pinch of skin between your thumb and first finger. If the pinch is more than 2–3 cm thick, you probably have too much fat on your body. If the pinch is ½ cm thick or less, you should probably try to gain some weight.

You probably think that fat people eat more than thin people. Just the opposite is often true. Fat people often eat *fewer* calories than thinner people. The problem is that they also burn up fewer calories. Fat people usually get much less exercise. One of the major causes of being overweight is lack of exercise.

It is not healthy to carry around too much extra fat. The extra fat can increase your chances of getting high blood pressure, diabetes, or heart disease.

To lose weight, people have to combine exercise with the right diet. Crash diets usually don't work. People get bored with them, or they become tired, or sick. The only type of diet that gives lasting results is the one that changes your eating habits. Usually this means cutting down on the amount of carbohydrates you have been eating.

People who want to gain weight also have to change their eating habits. They will probably have to eat foods that are both nutritious and high in calories.

Poor people in the United States may be underweight because they can't buy enough food. Chances are that the food they can buy does not supply all the necessary nutrients.

Standards of beauty change. In some ages plump people are admired. Sometimes thin people are in fashion. But your ideal weight shouldn't depend on fads. It does depend on age, sex, and body build. When you are at your ideal weight, you look good and you *feel* good. According to insurance companies, your ideal weight is the one that helps you live longer.

The biggest health problem for many teenagers is learning to live with their emotions. Your body is changing. Your place in society is changing. Many things are expected of you, and you probably aren't sure how to deal with all your new problems and new responsibilities.

The list of problems some people have seems endless — they have trouble getting along with parents, making friends, getting good grades, dealing with sex, anger, love, money, religion, work, prejudice, career choices, and even what to wear. Little problems throw them off. They don't trust themselves and don't have much fun. Sometimes their emotional problems make them physically sick. They get headaches, ulcers, and allergies.

If you have some of these problems you may need help. Discuss your problems with a person you like and respect. It helps to get

H 322

an outside opinion. Or suppose you have a problem getting along with certain people, such as your parents. Sometimes you can talk things out with them.

An important thing to remember is that you won't always have these problems. As you get older, you will probably learn to deal with them. You may still have problems, but at least they will be different!

Exploration 3. Keeping Healthy

Overview

The emphasis in medicine has shifted from treatment to prevention. That's what this Exploration is about, alerting students to the need for regular medical and dental checkups so that health problems can be avoided or minimized. Students may have gotten perfunctory "checkups" in the past that did not include all the tests described at the beginning of Part One. Tell your students that these standard tests should be performed when they get annual physicals, or else they are being shortchanged.

Some students may think they can't afford the regular professional services that are important in preventive medicine. In Exploration 5 they will get a chance to identify free or reduced-cost medical services available in their communities.

Point out to your students that doctors, dentists, and other health career professionals, like all other people, come in a wide range of abilities and experience. They should be prepared to "shop around" for medical services, just as they shop for other goods and services. If they feel that they are not getting adequate treatment from one physician, they have no obligation to continue seeing him or her. In addition, getting a "second opinion" is an established medical tradition, and people should feel free to get one.

A basic premise of this program is that each student should be treated like an individual, and individuals often have health problems. Students may also turn to you for counseling when they have problems.

Exploration
3. Keeping Healthy

THERE ARE TWO ways to deal with diseases — by curing them or by trying to prevent them. This Exploration is on prevention. You can find out how you rate at keeping yourself healthy.

1. Part One Personal Medical History

All questions in this Exploration are open to varying answers.

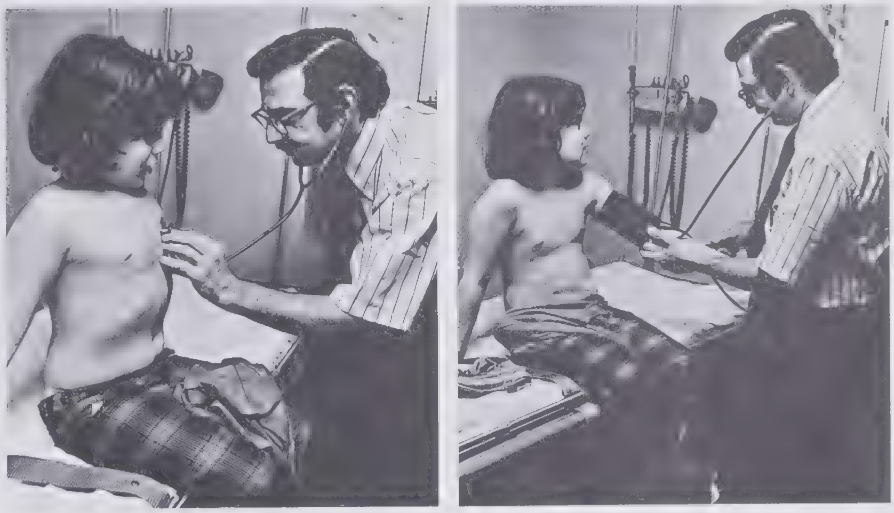
Have you ever had a physical examination?________ If so, when

was the last one? ________________________________

Did the doctor listen to your heart?__________ __________

Did the doctor measure your blood pressure?______________

When you get a physical exam, the doctor should listen to your heart and check your blood pressure.



You may also find that you can help some people who are unaware of any medical problems. It is not unusual for underachieving students to become achievers after getting eyeglasses, hearing aids, etc. If you are alert, you may notice undetected disabilities in your classes and be able to refer students to the school nurse or physician. Or you may be able to provide special help for students who have recognized disabilities.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) name two general methods of dealing with disease.

(2) describe some standard preventive medical measures.

Materials for Each Group

pencils
matchsticks
softballs

Time

Two days

1. Try to get students to record honest replies to questions about their personal health. Some of them will start to realize the importance of keeping healthy throughout their lives, not just when they are teenagers.

Hard cover page 324 corresponds with soft cover page 464.

→ H 323

Doctors can tell a lot about your health from a blood sample. It doesn't hurt much.

All questions in this Exploration are open to varying answers.

Did the doctor take a blood sample?______

Did the doctor take a urine sample?______

Your teeth are a very important set of tools. If you lose your own teeth, you can get false teeth, but they never work as well as your own.

Do you ever feel pain in a tooth when you eat very cold or very hot foods?______

Do your gums bleed when you brush your teeth?______

Have you ever been to a dentist?______ If so when was your last visit?______

Have you ever had your hearing tested?______

Have you ever had your eyes examined?______

Test yourself with the small version of a Snellen eye chart on the next page. Are you nearsighted?______

Prop up the book. If you have 20/20 vision, you can read the fourth line from 6 meters away and the last line from 2 meters away.

E

H N

D F N

P T X Z

U Z D T F

D F N P T H

P H U N T D Z

N P X T Z F H

→
H 324

A chest X-ray can help a doctor tell if you have TB or other chest diseases.

All questions in this Exploration are open to varying answers.

Have you ever had a test for tuberculosis? ____________

Have you ever had a chest X-ray? ____________

Have you had polio vaccine? ____________

When was the last time you had a tetanus shot? ____________

If you are not sure what shots you have had, ask your parents.

Have you had a shot for mumps, measles, or German measles?

After answering these questions, do you think you are doing a good job of trying to stay healthy? ____________

How could you do a better job? ____________

All questions in this Exploration are open to varying answers.

2. Part Two Physical Fitness

← H 326

The President's Council on Physical Fitness lists seven activities you can do to test your physical fitness. One of the tests is throwing a softball. The table shows you how to rate yourself. The table is based on how well many people your own age did. You can get a Presidential Award if you do better than 85 percent of your own age group.

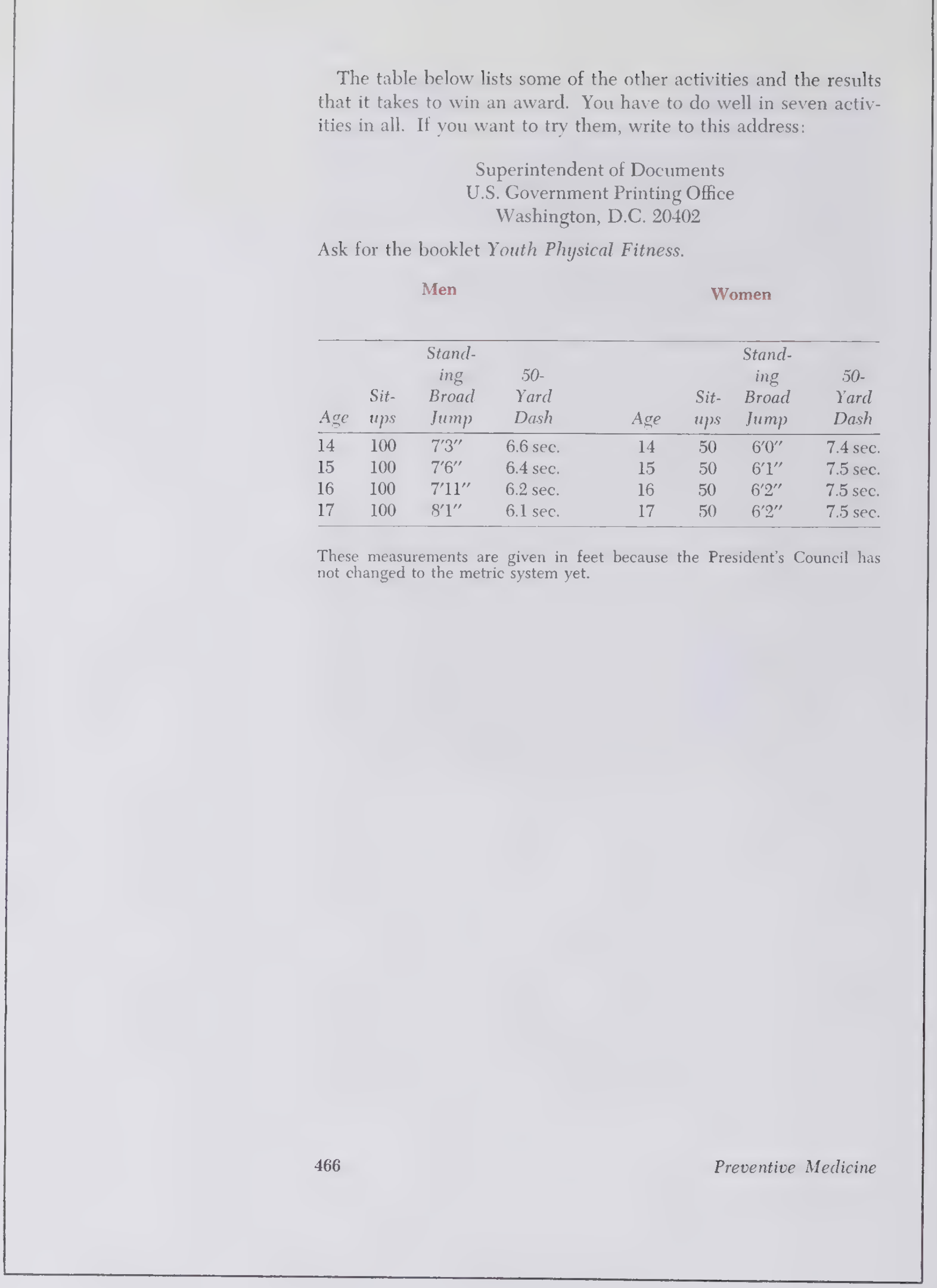
Don't start these activities by yourself. Check with your physical education teacher or coach before trying them.

SOFTBALL THROWING (distances in feet)

Men

	Age			
Rating	14	15	16	17
Excellent	208	221	238	249
Presidential Award	187	204	213	226
Good	181	198	207	218
Satisfactory	165	180	189	198
Poor	146	165	172	180
Women				
Excellent	114	120	123	120
Presidential Award	100	105	104	102
Good	95	100	98	98
Satisfactory	80	84	81	82
Poor	70	73	71	71

2. Students who want to try all seven activities in this fitness program can write to: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.



The table below lists some of the other activities and the results that it takes to win an award. You have to do well in seven activities in all. If you want to try them, write to this address:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

Ask for the booklet *Youth Physical Fitness.*

Men				**Women**			
Age	*Sit-ups*	*Standing Broad Jump*	*50-Yard Dash*	*Age*	*Sit-ups*	*Standing Broad Jump*	*50-Yard Dash*
14	100	7′3″	6.6 sec.	14	50	6′0″	7.4 sec.
15	100	7′6″	6.4 sec.	15	50	6′1″	7.5 sec.
16	100	7′11″	6.2 sec.	16	50	6′2″	7.5 sec.
17	100	8′1″	6.1 sec.	17	50	6′2″	7.5 sec.

These measurements are given in feet because the President's Council has not changed to the metric system yet.

Reading 4. The VD Blues

Overview

This is one of the few Readings that is a must. Venereal diseases, especially gonorrhea, have reached epidemic proportions in many parts of the United States, in spite of the fact that a cure is available. Perhaps the big message from this lesson is that there is a cure and that it is available from doctors or clinics. In many states young people can be treated at a clinic without fear that their parents will be notified. Check the regulations in your own community and be sure to stress this point if it is true.

Behavioral Objectives

After completing this Exploration, the students will be able to

(1) identify syphilis and gonorrhea as major venereal diseases.
(2) describe symptoms of syphilis and gonorrhea.
(3) describe appropriate treatment for each disease.

Time

One day

1. There are many old wives' tales that may have to be put to rest. One is that medication or an antibiotic left over from a doctor's prescription for another illness will

Reading
4. The VD Blues

Most cities have free public clinics where a person can get tested for VD.

1-2. **Syphilis** (*SIHF uh lihs*) is a disease that can spread through the population like juicy gossip. Someone with syphilis can give it to his or her sexual partners. They can give it to others. After a while a hundred people could get the disease.

3. Syphilis is caused by spiral-shaped bacteria. They enter the body through the moist surfaces of the male and female reproductive organs. This can only happen when there is sexual contact.

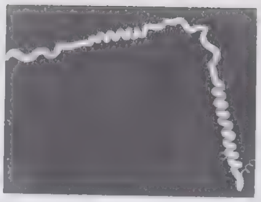
There are a lot of false ideas about catching syphilis. It cannot be spread by drinking water, food, or air. It is impossible to catch syphilis from toilet seats or door handles.

An early sign of syphilis is a painless sore. This is usually at the spot where the bacteria entered the body, but it may be anywhere. This sore is full of germs and is dangerous to other people. After a while the sore will go away. But the germs stay inside the body and keep reproducing. From three to six weeks later, a rash and new sores may appear on the body. At this stage, also, the infection can be spread to others.

cure VD. Toilet seats and door knobs must be discounted as a source of infection.

2. Heavy petting as well as intercourse may spread the diseases. Your students may have other names for heavy petting.

3. References to bacteria colonies in this Reading may remind the class of the work they did with bacteria colonies in Chapter 15. The same is true of the word "antibiotic."



A syphilis bacterium can invade your heart or nervous system years after you get an infection.

Syphilis can be discovered at any stage by a blood test. In fact, many states require this blood test for people who are planning to marry.

Syphilis can be treated successfully with an antibiotic called penicillin. If you get syphilis, go to a doctor or a clinic. Don't kid yourself: You can't cure yourself, and it won't go away. Even if the signs disappear, you still have syphilis and can spread it. In fact, the worst stages of the disease don't show up for a long time.

And remember that you can catch it more than once. Unless both partners are treated, the disease will continue to spread.

Without treatment, the victim is in bad trouble.

1 out of 200 untreated people becomes blind.
1 out of 50 untreated people becomes mentally ill.
1 out of 25 untreated people becomes crippled.
1 out of 15 untreated people develops heart disease.

Gonorrhea (GAHN *uh ree uh*) is another disease of the sex organs. Gonorrhea and syphilis are also known as VD (venereal diseases). Gonorrhea affects more people in the United States than syphilis does. It spreads like a forest fire.

Gonorrhea can damage the reproductive organs. If it goes untreated the person who has it may be unable to have children.
4. Gonorrhea can cause heart trouble, arthritis, blindness, or death.

Men can tell if they have gonorrhea easier than women. For a man, urinating may be painful. He will discharge pus from his penis. If a woman is infected, she may notice that her vagina is sore. She may have pain when she urinates. Or she may have a discharge from her vagina. Or she may not notice anything different about herself for a long time.

There is a blood test for gonorrhea. But it isn't always reliable. The only sure test is to have a doctor take a sample of the suspected bacteria and see if it grows into a gonorrhea colony.

Gonorrhea can be cured by using antibiotics. If you suspect that you have this disease, go to a doctor or a clinic for help. Don't kid yourself: You can't cure yourself. If you find out you have gonorrhea, tell the people you had contact with. And remember, you can also catch gonorrhea more than once.

Research You Can Do

If a pregnant woman has gonorrhea, the bacteria in her vagina can infect her baby's eyes and cause blindness. Find out what hospitals must do to protect newborn babies from blindness caused by gonorrhea.

4. Check your city and state health departments as well as your Board of Education for films on the venereal diseases. The Metropolitan Life Insurance Company has a pamphlet that can be requested for class use.

Exploration 5. Where Can You Go for Help?

Overview

Public health officials know that lower-income neighborhoods often don't lack available medical services, but that the people in the neighborhoods don't know about them or how to use them. They may also be apathetic about their health, partly as a result of thinking that they cannot afford medical treatment.

Your job in this crucial Exploration should be to help students uncover all they can about health care services in their communities. You will probably be able to get local health officials and professionals to provide the

← H 329

Exploration

5. Where Can You Go for Help?

← H 330

1. Knowing how to care for your body is only half the problem. You must also know where to go for help. In this Exploration, you will find out what health services are offered in your own community.

Is there a nurse at your school? Varies.

Is there a doctor who can be called in an emergency? Varies.

Does your school have first aid kits and people who know how to give first aid? Varies.

If you don't have a family doctor and you don't have much money, where can you go for help? Varies.

Where is the closest hospital? Varies.

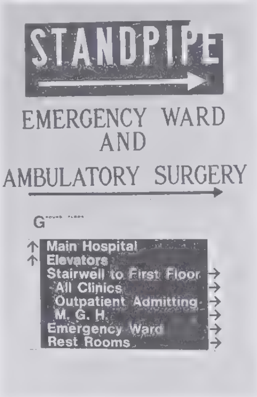
Does it have an emergency room? Varies.

Where can you go to get your teeth cleaned and checked? Dentist or a clinic.

Where can you get your hearing and eyesight tested? Clinic.

Where can you get shots? Doctor or a clinic.

Where can you go for a chest X-ray? Doctor or a clinic.



class with useful information. If it is at all possible, try to visit some of these services as a group.

After completing this chapter, your students should feel much more responsible and knowledgeable about keeping themselves healthy or getting well.

Behavioral Objective

After completing this Exploration, the students will be able to

(1) name or describe at least four community health services.

Time

Two days

1. If you plan to visit community health services as a group, have students prepare a list of questions beforehand. You may want to record on tape the comments by the various health officials. The tape can be listened to by students who were absent on the day of the trip.

Do you ever get the feeling that you spend a lot of time filling out forms?

Where can you get a physical checkup? Doctor or a clinic.

If you are concerned about VD, where can you go for help? Doctor or a clinic.

Suppose you are having an emotional problem. Where can you call and find someone to talk to 24 hours a day? Some neighborhoods have a special phone number to call when someone is uptight.

Are there counselors at your school you could talk to? Yes.

Where can you go for help if you think you are pregnant? Varies.

Where can you go for help if you have a problem with drugs? Places like Odyssey House, Dare, or similar places.

A lot of cities have street clinics and free clinics where people can get medical help without a hassle or a big bill.

Use Your Wits!

Use this page to write down the things you think you should do to improve your health or to keep healthy. Check off each thing as you do it. You don't have to hand in this page to your teacher.

Students express their needs.

Hard cover users: To reproduce the Use Your Wits! for this chapter please turn to page T 54 or direct students to the Laboratory Supplement.

Careers in Health

Health is a field with many openings for careers and with fairly equal opportunities for both men and women. The need for people in the health field will grow, particularly in the inner cities and in areas outside the cities.

What You Do	Where You Do It	What You Need
Certified Laboratory Assistant (CLA) Collect samples of blood and other body fluids; make slides so that they can be examined with a microscope, or run chemical tests on them	Laboratories in public or private hospitals; public health departments or other agencies	High school plus one year in a CLA school approved by the American Medical Association
Dental hygienist Clean a patient's teeth; advise patients on teeth care; make X-rays of teeth for a dentist to examine. A school hygienist teaches dental health in schools and advises parents on their children's dental needs.	Dentist's office; private company plants or factories; schools; public health departments	High school plus a two-year course as a dental assistant in a community college or technical school. School and public health dental hygienists need a college degree
Dental laboratory technician Make plaster or wax models of a patient's teeth and gums; make a bridge or plate from a model.	Dentist's office; your own laboratory or workshop	High school plus a two-year course in a community college or technical school
Medical technologist Examine diseased parts of the body and count blood cells with a microscope; grow bacteria for tests and experiments; match blood for blood transfusions and run a blood bank.	Public or private hospitals; public health department and other government agencies; private drug and medical testing companies	Three years of college plus one year on-the-job training in a hospital
Nursing aide Aid nurse by helping patients with meals, bathing. Male aides may also do heavier work (setting up heavy equipment, moving patients, and so on.)	Public and private hospitals (including Armed Services hospitals)	High school (preferred, but not required) plus three months on-the-job training
Nutritionist Teach food science and the rules of good nutrition; work in nutrition research with a team of other scientists	Home economic departments in high schools and colleges; government, university or commercial laboratories; public health departments	Three years of college (public health nutritionists need a Master's degree)

What You Do	Where You Do It	What You Need
Operating room technician Prepare supplies and equipment in hospital operating rooms; work as part of the medical team during operations	Public and private hospitals	High school plus four to six months classroom instruction and practice
Physical therapist Help people with nerve, bone, or muscle disorders to use their bodies normally; perform massage when required by a doctor; advise people on exercise	Public and private hospitals and public health services; sometimes work in private homes	Training at a university physical therapy school or a university hospital
Practical nurse Help get patients ready for a nurse or doctor; give different kinds of shots; take care of medical instruments; work in private homes with public health nurses	Public health departments; public and private hospitals; doctor's offices; private homes	Special programs in community colleges, technical schools, public health agencies, and hospital schools
Psychiatric aide Help look after mentally ill patients in psychiatric wards and hospitals	Psychiatric hospitals; psychiatric wards of general hopsitals	High school (preferred but not required) plus three months on-the-job training
Registered nurse Care for patients under the direction of a doctor; help doctors examine and treat patients. (There are also special kinds of registered nurses such as public health nurse, nurse anesthesiologist, and so on)	Public and private hospitals; private nursing services; schools; Armed Services; hospitals	Nursing school, approved by your state
Social service aide Work with a social worker; make and keep records; help people find medical care; interview people needing welfare	Government departments such as family service agencies, child welfare agencies, clinics, and the courts	High school plus special program (usually two years) in a junior or senior college. Or high school plus on-the-job training

Biology Hall of Fame

Left Virginia Apgar (1909–1974) invented a test, the Apgar Score, used to check newborn babies for birth defects.

Right William Beaumont (1785–1853) studied the human digestive system with the help of Alexis St. Martin.

Left Christiaan Barnard (*b.* 1922) performed the first human heart transplant.

Right Rachel Carson (1907–1964) wrote a book called *Silent Spring* that made everyone think about the way people are destroying our environment.

Left George Washington Carver (1864–1943) showed farmers how to improve soil and get better crops, and invented ways of making such things as soap, dyes, and cheese from peanuts and pecans.

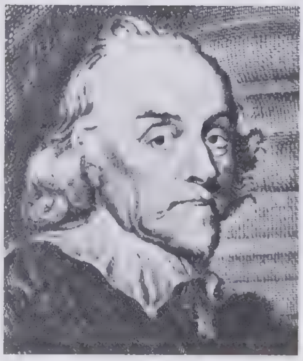
Right Barry Commoner (*b.* 1917) studies pollution and tries to warn the public about how some modern ways of doing things are ruining the environment.

Left Charles Darwin (1809–1882) first stated a theory of evolution in his book *The Origin of Species.*

Right Charles Drew (1904–1950) discovered how to separate blood and how to store it in blood banks.

Left William Harvey (1578–1657) first suggested that blood circulates in the body and showed that blood could not be brought back to the heart by the same blood vessels that carried it away from the heart.

Right William Hinton (1883–1959) was an expert in venereal diseases and invented the Hinton test for syphilis.



Left Robert Hooke (1635–1703) was the first person to observe cells with a microscope, and he named them cells. This is one of his microscopes. There is no known picture of Hooke.

Right Edward Jenner (1749–1823) showed that vaccination can prevent some diseases.

Left Percy Julian (*b.* 1899) developed the drug cortisone, which is used to treat arthritis.

Right Louis Leakey (1903–1972) and his wife Mary and son Richard showed that there have been human beings on the earth for more than 2 million years.

Left Mary Leakey (*b.* 1913) did research with her husband Louis in East Africa, where they discovered fossils of some of the earliest human beings.

Right Richard Leakey (*b.* 1940) took part in his family's research in Africa and, with his mother Mary, continued the research after his father's death.

Left Anton van Leeuwenhoek (1632–1723) was one of the first people to use a microscope. He discovered bacteria.

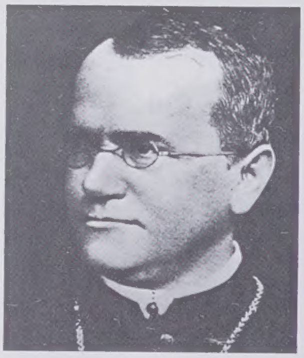
Right James Lind (1716–1794) cured British sailors of scurvy by giving them citrus fruit.

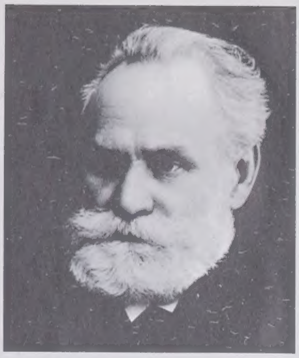
Left Marcello Malpighi (1628–1694) used a microscope to discover the capillaries, the link between arteries and veins that Harvey had not been able to find.

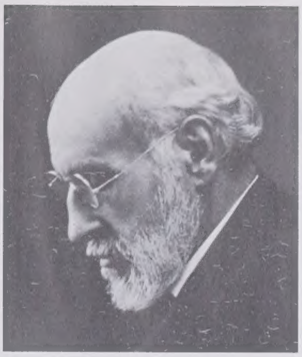
Right Margaret Mead (*b.* 1901) has studied human societies in many places and has discovered a great deal about how people behave, especially children and young people.

Left Gregor Mendel (1822–1884) experimented with pea plants and discovered the laws of inheritance.

Right Louis Pasteur (1822–1895) discovered many things, including how to keep milk from going sour by heating it (pasteurization) and how to prevent rabies by immunization.







Left Ivan Pavlov (1840–1936) experimented with dogs and showed that conditioning is an important part of learning.

Right Santiago Ramón y Cajal (1852–1934) made important discoveries about the nervous system and how nerves work.

Left Jonas Salk (1914–) discovered the first vaccine that worked against polio.

Right Andreas Vesalius (1514–1564) was the first person to study the human body scientifically. He has been called the Father of Anatomy.

Left James Watson (*b.* 1928) working with another scientist, Francis Crick, discovered how cells pass on characteristics and made the first accurate model of DNA.

Right Louis Tompkins Wright (1891–1952) was a leader in research with antibiotics and founded the first interracial hospital where black doctors and nurses could be trained.

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